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A magazine established by the co-workers of Edward H. Angle, in his memory. . . . . .

The Application of the Principles of the Edgewise Arch in the Treatment of Class II, Division 1 Malocclusion

(A discussion of the paper by Charles H. Tweed, D.D.S., published under the above title in Vol. VI, No. 3 of *The Angle Orthodontist*)

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Note—When the author, or better the editor, of the present discussion was asked to take the assignment he was confronted with the problem of determining whether he himself was following the treatment of Class II, Division 1 malocclusion as Dr. Angle had taught it or whether he had gradually modified it over the past ten years to conform to subconscious convictions of his own that he might have accumulated in this length of time.

In order to check his own memory he has called upon the authors whose names appear together with his above. These four were selected because all of them were in attendance at the Angle School while the Edgewise Arch was being developed and they were the only persons in the United States who had a full course of instruction in this appliance under Dr. Angle. Each of these authors has submitted his or her plan of treatment and a general criticism of Dr. Tweed's paper. These contributions have been combined in this discussion and it has been checked by each author before being submitted for publication. It therefore represents a composite viewpoint of these four authors. A.G.B.

In order to get to the center of Dr. Tweed's arguments it is necessary to discuss some things that he implies as well as those which he states. An example of this is to be found in the early paragraphs of the paper where he discusses the normal denture and also the hopelessness of trying to standardize treatment. He claims that no two operators will visualize any given case in exactly the same way and with this view there are few who would quarrel. But then comes the following:

"Ever present in the back of my head is an image of the profile of a skull and a face, which to me is the normal. (Figs. 1 and 2.) One glance at an unbalanced face or teeth in malocclusion and there is a comparison before me, as clear as any photograph can depict, between the case involved and my conception of the normal. To many of you my conception of the normal (this image in the back of my head) would not be beautiful if you could see it, because some of you would say this normal of mine has slight Class III tendencies. Typal differences should be considered, but my vision of the normal allows of no variations—it seems a piece of precision machinery.

"You have my confession now—I look with loving eyes on a prominent mandible. (Fig. 2.) Occasionally, when nature has created my idea of the normal in some individual, my impulse is to pass a hand over it—to feel it so that I cannot forget. Some of you think that my normal has a mandible that is slightly anterior to the real normal in its relation to the skull as a whole and that the individual teeth in the mandible are a little too upright or vertical. Yes, the lower incisors and cuspids are so vertical that in the fresh specimen they might even give the impression of retruding slightly. There is no protrusion of the alveolar process in the lower incisal region and the mandible is firm and prominent.

"Do I always succeed in reproducing this normal of mine? Seldom, if ever, am I entirely successful, but the similarity of relationships displayed by the models before you will demonstrate my efforts to reproduce this image of mine (Fig. 3)."

Just what is meant by "my normal has a mandible that is slightly anterior to the real normal . . . and that the individual teeth in the mandible are a little too upright or vertical"? What is "this normal of mine"? For that matter, what is the "real normal"?

There are two fundamental fallacies here. In the first place, the word "normal" should not have been used. A normal cannot be "too" anything. What Dr. Tweed actually means here is not a normal mandible but one which has been overtreated in an effort to avoid something that he fears may happen unless he overcompensates for it. The second fallacy is in the conception of the normal itself. Here he lays himself open to serious criticism. He admits that he views the prominent mandible with fondness and points with apparent pride at the similarity of his results.

Has all of Prof. Wuerpel's influence on Dr. Angle's teaching been in vain? Is the significance of the chapter on Facial Art completely lost sight of by one who quotes it? Has all of the work done by Hellman, Krogman, Oppenheim, Broadbent and the host of others who have labored over the problem of dento-cranial relations been just wasted effort, that we should continue to hear of *the* normal denture or face? The work of all of these men points unmistakably to the conclusion that the normal as a single type does not exist. Heredity plays the major role in the determination of type but we have in addition to this those thousands of tiny mutations or differ-

ences between individuals of the same stock, each of which modifies what might be thought of as the pure strain. The normal is thought of as being any individual in which all of the factors are blended harmoniously into a coordinating unit. And even this unit shows marked changes in its fundamental relationships according to age.

Treatment

With the avowed objective of Dr. Tweed's treatment we have no quarrel. He says:

> "The plan of treatment from the beginning is to prepare the individual arches in the most efficient manner possible for the distal movement of the maxillary teeth en masse with a minimum forward displacement of the mandibular teeth from the normal in their relation to the body of the mandible."

With the methods employed for gaining these ends, as well as with the reasoning by which these methods are arrived at there is abundant cause for disagreement. He says:

> "The plan of treatment should be divided into two stages, (1) the preparation of a more stable form of stationary anchorage in the lower arch and the elimination of toe-hold or stationary anchorage in the upper arch. (2) Distal movement of the maxillary teeth en masse, along with the development of the body of the mandible without forward displacement of the mandibular teeth."

Anyone who has examined histological material prepared from tissues around moving teeth would agree that there is no conceivable mechanical device that can add to the resisting power of a tooth beyond the degree represented by the *undisturbed* tooth. The placing of so much as a single ligature for separation is followed by alterations in the structure of the surrounding bone which is weakened in proportion to the magnitude of the force and the duration of its operation. To talk of reconstructing or re-enforcing anchorage after "limbering up" the tissues is comparable to locking the stable after the horse has been stolen. If one wishes to preserve anchorage it is imperative that he do everything that he can to disturb the investing tissues of the teeth as little as possible. Since they must be disturbed if used at all, let us examine the nature of the disturbance with the various types of anchorage.

First of all it should be recognized that there is no such thing as true anchorage available within the mouth. We have at our command only different degrees of resistance. These differences are determined mainly by (1) the form and area of the root surfaces and (2) the nature of the surrounding bone. A tooth is *suspended* in its alveolus by the peridental membrane fibers and resists movement through a tensing of these fibers. The greater the surface area on the tension side of the root the greater the number of fibers

resisting the force, hence the the greater the resistance available. The nature of the bone being acted upon is the other factor involved. It is common clinical knowledge that any tooth will move more readily in some directions than in others and that some teeth are more resistant to *any* movement than are others. With the exception of the incisors, mandibular teeth are more resistant than those of the maxilla. But given any tooth, we have various means of manipulation at our command which will determine how much of its available resistance we will use.

If the force we are employing against a tooth causes that tooth to tip in a direction opposite to the force, we employ the term "simple anchorage;" while if we use methods that will not permit of such tipping we say it is "stationary anchorage." Histological investigation has shown us what takes place under such conditions. In the case of simple anchorage a stimulus is applied to the chest of the alveolar wall and this leads to a rapid and progressive transformation of the bone from the crest toward the apex. We are thus throwing our load on a relatively small group of fibers. Bone reaction at this level leads to the formation of osteoid, a less resistant tissue, and the stimulation is thus passed on to a lower level. In time all of the bone of the socket wall is transformed to osteoid and the resistance of the tooth is almost completely spent.

The aim in the employment of stationary anchorage should never be the realignment of the tooth axes for the purposes of mechanical advantage, as Dr. Tweed advises. We are not dealing with posts in the ground but rather with bodies (the teeth) that are set in living tissues, which tissues are capable of change in response to applied forces. Our objective should be the enlisting of as many fibers of the membrane as possible against the forces we are to apply. This implies the use of a device that will simultaneously tense all of the fibers possible on the tension side. Obviously it is impossible to determine this accurately and adjust for it, nor is it possible to make just the right allowance for such factors as tissue play and arch resiliency. These must be estimated and adjusted for by means of slight torques and bends which we shall consider later, but they should never be carried to anything like the limits indicated in Dr. Tweed's paper where he says to "bury the distal of the crowns, if necessary."

Confining ourselves to the mandibular teeth for a moment, we find that

> "bracket bands are cemented to all of the teeth, except those immediately anterior to the molar anchors . . . After .016 inch round steel arches are inserted, with bends to begin uprighting the anchor teeth, the case is dismissed for from ten to fourteen days for preliminary limbering up of the tissues . . . During the second visit, provided the crowns of the lower incisors are not flaring forward with loss of contact, an ideal arch is made of .021 x .024-inch steel."

Let us examine the mechanics of this arrangement.

Figure 1 (A) represents a tracing of a photograph of an actual and typical Class II mandibular arch equipped according to the described technique, except that a band is shown on the second bicuspid. The excessive vertical curvature of the arch should be noted particularly. Figure 1 (B) represents such an arch in its rest position (dotted lines) as compared with

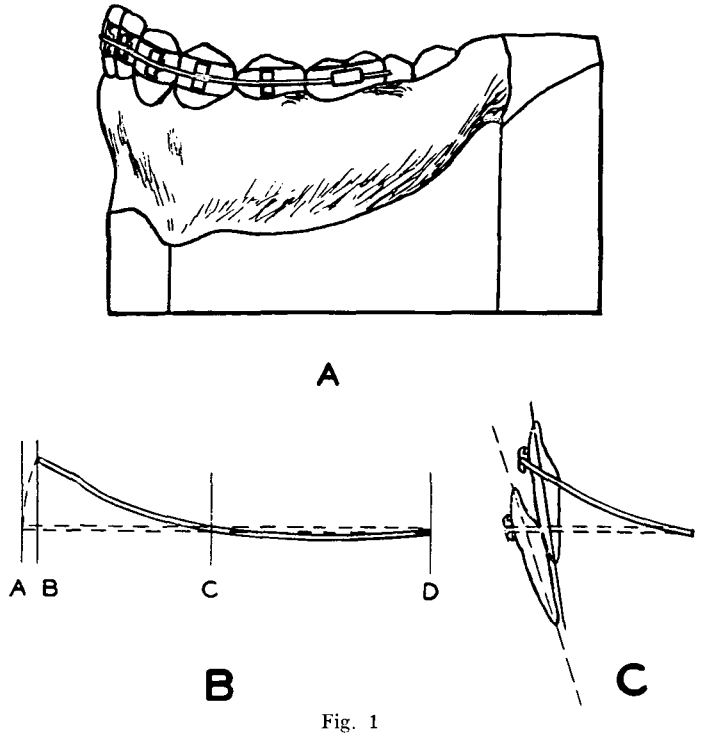

Fig. 1

its distorted position (solid lines). It also shows the course that will be followed by the anterior segment of such an arch in its return to a rest position. It might be argued that the leveling off of the mandibular teeth would be accomplished as much by the elevation of the bicuspids as by the depression of the incisors, but when we consider that the full force of occlusion would tend to hold the bicuspids this possibility seems remote. We are therefore forced to conclude that the major movement would take place between the

points A and C which again increases the severity of the arc through which the incisors tend to travel. It is plain to be seen that the dental arch must be lengthened if the teeth are to follow the course of the relaxing steel arch and further, that most of this lengthening must take place in the incisor segment. Furthermore, since the relationship between round arch and bracket is purely a simple anchorage the resulting movement must be a forward tipping (Figure 1, C). These are the very mechanics we would use if we *desired* to tip these teeth labially. It would seem therefore that Dr. Tweed was inviting the very condition that he is so anxious to avoid. By such movement, part of the resistance of the weakest teeth in the mandible is seriously lowered and, as pointed out above, there is no possible way of restoring it. If one wishes all of the anchorage available from a group of teeth it does not seem reasonable that he should start by causing a breaking down of the tissues on which he is going to depend.

The fact that such undesirable movement is apparent in some of Dr. Tweed's cases is attested by his own words on page 202:

> "During the second visit, *provided the crowns of the lower incisors are not flaring forward with loss of contact,** an ideal arch is made . . . " etc.

Other evidence is given on the same page where he says

> "One eighth of an inch anterior to the alignment sheath a T is soldered to the arch and a steel ligature is tied around the sheath and T, to prevent any arch movement through the sheath and *to keep the teeth in contact.*"*

This tendency for spaces to appear is not peculiar to the edgewise arch, in fact it should and does appear less with the proper use of this mechanism than with any other, and without the employment of a T.

On the basis of Dr. Tweed's admissions as well as on the basis of our own experiences and those of others it may be stated that the round steel arch should not be used to "limber up the tissues" if we are subsequently to expect the fullest degree of resistance from those same tissues. The apparent reason for its use is to enable the operator to apply the ideal, square-sided arch more quickly. If this is actually the case, it would seem as though the ideal arch had assumed the proportions of a fetish and this was never intended. No mechanical principle should ever be allowed to obscure the realization that we are dealing with living tissue. Dr. Angle was always insistent on the fact that any appliance should bow first to physiology, regardless of mechanical efficiency or beauty.

A few words relative to the ideal arch principle are here in order. The edgewise bracket was first developed as an auxiliary to the ribbon arch and

*The italics are the author's.

with this appliance it was the custom to adapt a flat-sided arch to brackets on malposed teeth. In other words the arch was first conformed to the deformity and then gradually ironed out to a symmetrical pattern, carrying the teeth with it. Every effort was made to avoid the tipping of teeth that were to be used as anchorage, and the ultimate outcome of this endeavor was the introduction of torque. But as stated above, torque was an adjustment that had for its object the compensation of tissue play and arch resiliency because even with this flat-sided arch teeth would tip. This was particularly true of the lower incisors when they were being depressed and when elastics were being worn.

The arch forms resulting from the process of ironing out the irregularities in the arch-wire were frequently grotesque. Normal dental arch form was too frequently forgotten in the effort to bring all of the teeth into position on the arch. The abnormal widening of the cuspid and bicuspid areas and flattened incisal segments were common. Cases left in this condition after treatment too frequently relapsed in the settling process.

Dr. Angle recognized this and sought to give the operator a guide or pattern, through a determination of the size and typal form of the arch in question, before treatment was begun. In this he was reverting somewhat to "E" arch principles but now he was working through a bracket engagement and with a carefully measured arch. It was immediately recognized that this was an important principle and it was stressed in his writings and in those of others—the author's included. Apparently it has been deified and this is unfortunate.

No one can know how Dr. Angle would have felt about the ideal arch principle had he lived to see it in operation on a large number of cases. But one thing is certain: he would never have insisted on its application at the expense of tissue. Having gone through all of the trials incident to the manipulation of anchorage with the "E" arch and finally having almost completely overcome this major obstacle with the ribbon arch, it is not likely that he would have thrown all of his experience overboard and gone back to the beginning, just for the sake of a mechanical concept. Sooner than see the ideal arch elevated to such importance it would be better to go back to the conforming of the arch and reserve the ideal form for the finishing touches on the case. Indeed, this can sometimes be done to advantage.

The question that naturally arises now is whether or not there are methods, other than those advocated by Dr. Tweed, for the treatment of the type of case under discussion that do not have inherent in them the dangers referred to above. The unanimous opinion of the authors of this discussion

is that such methods do exist and it is our purpose to indicate what they are. Let us consider the treatment of the case already referred to as we would handle it.

First of all, every tooth would be banded up to and including the first molars and occasionally the second molars. Tie bracket bands would be placed on all except the last tooth, and this would carry a tiny rectangular tube. An ideal arch would be formed of rectangular gold arch wire according to the size of the teeth and the estimated form of the dental arch in

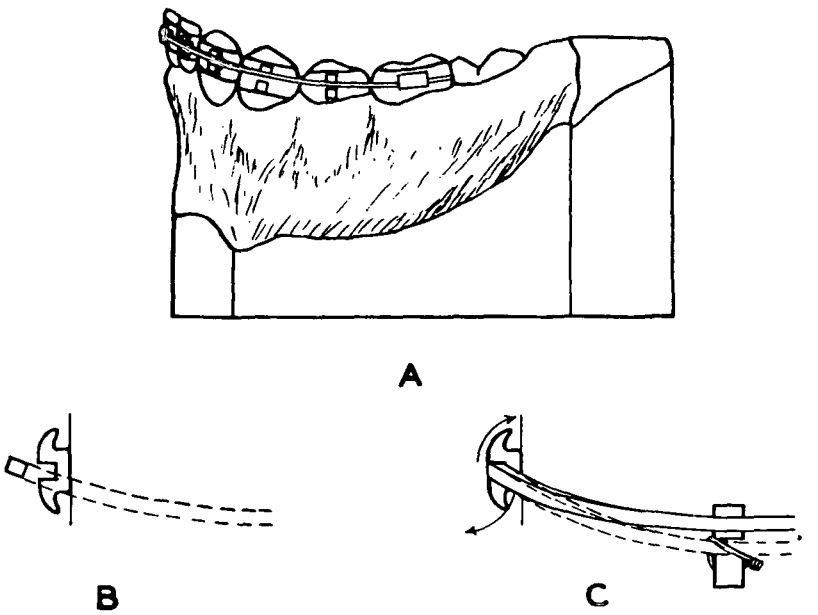

Fig. 2

question. If we were to place such an arch in the tiny tubes and raise the anterior portion of it to the level of the incisor brackets we would notice two conditions, viz: (1) the top and bottom surfaces of the arch would not lie in the same planes as do the corresponding surfaces of the slot in the bracket (Figure 2, B) and (2) the arch would lie occlusally to the slots of the bicuspid brackets. If such a relationship between arch and incisor brackets continued following the placing of the arch there would be an excessive root torque acting in a labial direction. Hence it is necessary to reduce this torque until the arch can be placed with comfort to the patient. This, how-

ever, will not alter the relation between arch and bicuspid brackets. A ligature is thrown around the gingival wings of these and the arch is gently tied down in this area (Figure 2,C). It should be apparent that this method of tying would have the same tendency to depress the incisors as does a round arch, but in addition it places a labial root torque on these teeth which prevents their outward flaring.

It will be found that two or three adjustments will suffice to gain bracket engagement of the bicuspids and that during this time considerable depression of the incisors has taken place. No forward flaring will be noticed if, at each appointment, the arch is tested for torque in the anterior region. Such testing is done by placing the arch in the anterior brackets and noting its relation to the molar tubes. In order to have a slight amount of torque active the arch should lie slightly to the occlusal of the molar tubes (about ⅛ inch). Should this relationship not obtain, a slight increase in the torque should be made. However, attention is called to the fact that the arch was at first actually *detorqued* and that subsequent adjustments are merely a restoration of the normal form of the arch.

In actual practice with the edgewise arch the above described technique is not often necessary, as the arch can usually be placed in the incisor brackets right from the beginning of treatment without excessive force. But care and judgment must be exercised in tying the arch down to the bicuspids because here we are employing a very powerful and effective lever which acts directly on the incisor roots. As soon as all brackets are engaged, which is usually by the third appointment, the elastics may be applied and the mandibular arch used for anchorage.

It should be understood that the authors do not claim that by this technique they have not disturbed anchorage. They do claim, however, that they have disturbed it *less* by avoiding stresses at the most vulnerable points, i. e., the crests of the alveolar process, and have instituted, right from the beginning, the tooth movements that Dr. Tweed strives for after he has placed his square-sided arch. It should be noted also in this connection that even after "limbering up the tissues" Dr. Tweed finds it impractical to place an arch which accurately fits the bracket. He uses a steel arch of smaller dimension than that called for and this can only result in a certain amount of play. Such play means either further breakdown of anchorage or additional torque to compensate for it.

Turning to the upper jaw, we read:

> "Stationary anchorage exists above in portions of the maxillary arch and must be broken down or converted into simple anchorage."

Here we have a misconception as to the nature of second order bends which

seems quite prevalent. Just what is second order movement and upon what physiological reactions does it depend?

The effectiveness of this form of mechanics rests upon the generally accepted principle that a lever, working upon a tooth in a gingival or occlusal direction will cause that tooth to tip, with its apex as the center of rotation. This is exemplified in all sorts of ways from unsupported bridge abutments to "E" arch mechanics. Let us examine the latter.

If a molar tooth is equipped with a band and a tube, into which an arch fits, we have the application of such an arch. If we pull such a lever occlusally in the incisal region and permit full freedom of the arch in all but the molar area, a distal tipping movement of the molar will ensue with the distal root apex acting as the center of rotation. (Figure 3). This was the principle behind both "E" arch and ribbon arch treatment of Class II cases.

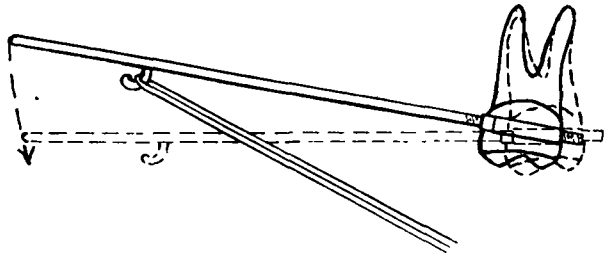

Fig. 3

The effectiveness of this type of mechanics depends upon the physiological reaction that is called forth by the force. It must be remembered that the tooth is *suspended* in its socket by tiny connective tissue strands and that when side forces are brought to bear upon the tooth some of these are tensed and some are relaxed. If a gentle force is applied the initial reaction takes place at the alveolar border with a minimum of disturbance at the apex. If, on the other hand, great force is exerted in the same direction, the tooth is jammed against the crest, circulation is interfered with and bone reaction is inhibited at the site where we most desire it. It now takes place at the apex because the crest becomes a fulcrum. This is highly undesirable since such apical movement will naturally be in the opposite direction. Now since second order bends are nothing but a series of such levers as that described above it follows that the magnitude of the bend determines the amount of force applied. It is, therefore, vitally important that we keep

the degree of our bends well within the limits of proper stimulation and that we do everything to prevent disturbing influences from reaching the apex.

Since in second order bends the object is to tip the teeth with their apices as centers and since the maintenance of these centers is of the first importance to the success of treatment and further, since *any* movement is very apt to initiate tissue changes in these origins, why is it not best to exert all our efforts to preserve the status quo of the apical tissues rather than to disturb them first through a "limbering up" process? A number of procedures advocated in Dr. Tweed's paper as necessary to the preparation of anchorage should be looked upon in just the opposite light. They are in fact, destroyers of anchorage and should be studiously avoided. Let us take as an example the management of protruding and spaced upper incisors.

The advice is given that this portion of the treatment should take preference over distal movement. It is done by retracing the anteriors by means of a loop in the bicuspid or molar region and tensing the loop by means of a ligature thrown around the molar tube and a T soldered to the arch anterior to it. No bands are placed on the incisors, the movement being a simple backward tipping of these teeth.

Such a movement must naturally result in an increase in the overbite already excessive in this type of case, since the apices of these flaring teeth would act as the centers of this movement. At the same time there is a forward force acting on the molar, tending to bring it forward. Furthermore as Strang has pointed out, such movement will affect the alveolar bone throughout the entire course of the root. Each adjustment of a loop is followed by a double movement of the tooth, in this case, first the crown and then the root. The net result is that we have weakened the very sites where we most wish strength. If the buccal teeth are all present and in contact they will share in the disturbance. Further than this, we have jeopardized our chances of depressing the incisors to the necessary degree even though we may have tipped them back and closed their contacts. Our anchorage for this movement lies in the bicuspids and molars and if these be disturbed unduly we will not be able to overcome the resistance to a depression of the incisors.

In the upper arch as in the lower, the effort should be made to conserve, not to destroy anchorage. Even in those cases exhibiting spaced and flaring upper incisors we should institute our proper tooth movements as promptly as possible. This usually means the second or third appointment although it is occasionally advisable to taper our arch form slightly in order to obtain bracket engagement without too much tooth movement. If we now institute second order movements with bends and elastics we have several advantages:

(1) We are beginning our treatment promptly, and simultaneously with that of the lower jaw. (2) Treatment is instituted at the sites where the major amount of movement must take place, i.e., the tip-back of the buccal teeth and the depression and retraction of the incisors. (3) The forces are being applied to fresh tissue, giving us the twin advantages of speedy reaction and a minimum of undesirable tooth movement. (4) Most, if not all, of the incisal spacing will be taken care of at the same time, through the action of the second order bends. This point will bear a little explaining.

If a piece of tempered wire 3 inches long be thrown into a series of bends it does not affect the length of the wire but now its ends are no longer 3 inches apart. Suppose we were now to straighten such a wire out against its temper and fasten a series of small objects to it at ½ inch intervals. If we now released the wire and let its temper carry it back to its bent condition the objects fastened to it would be closer together. There is a strong squeezing action in the second order bends as anyone will testify who has tried to maintain a space in the arch while employing this type of mechanics. It is this action that tends to close incisor spaces. Any such spaces that may remain after the distal movement of the buccal teeth has taken place may be taken care of by employing the elastics in their usual position but with the arch running free in the bicuspid brackets.

If Dr. Tweed were correct in his assumption that the upper incisors constitute a drag force on distal tipping mechanics it should be easily proved. One would have only to compare the speed of reaction of a case treated as outlined above, i.e., with all teeth banded and moving simultaneously, with one where the second order bends were placed on the buccal teeth and the arch was caused to lie anterior to and entirely free of the incisor teeth. If these incisors constitute a drag instead of an aid, one would naturally expect more rapid movement with the latter treatment than with the former. Actually the reverse is true. In the usual case of high canines, where the buccal teeth have drifted forward and the incisors are in approximately their correct position this latter form of treatment has been followed for the past eight years. The actual speed of reaction is about one third that with the full strap-up as judged by the time taken to move the buccal teeth to a Class I relation. The incisors contribute *something* to the movement that is as yet not satisfactorily explained.

There are several points in the paper relative to the wearing of elastic ligatures that should be discussed. We read:

> "The protrusive upper incisors afford a most potent toehold or stationary anchorage and this condition, if present, must be overcome before these teeth are banded and intermaxillary elastics worn; otherwise very undesirable anterior movement of the mandibular teeth is very apt to occur."

And in a later paragraph:

"This, however, seems quite certain: when torque force is spent the incisor teeth attached to the arch wire no longer being tipped begin to drag or create toe-hold or stationary anchorage against distal movement of the maxillary teeth en masse, *which begins to strain anchorage in the mandibular arch.*"*

We would submit that the nature of the anchorage does not affect the pull of the elastic. A rubber band at given distension pulls equally hard against simple and stationary anchorage. If these teeth were suddenly to attain a condition of stationary anchorage it would not in any way increase the pull on the mandibular teeth. If an elastic is stretched between two points it is exerting its maximum strength for that amount of distension and nothing can increase the strain except a further separation of the points of attachment.

No one will deny the fact that anchorage can be strained by elastics, but the factors responsible are the magnitude and duration of the force, or in other words, the size and distension of the elastic on the one hand and the length of time it is operating, on the other. Given a stationary anchorage in the maxilla against a stationary anchorage in the mandible and the maxillary teeth will show the greater movement. If, however, a stationary anchorage in the maxilla is pitted against a simple anchorage in the mandible, or against an anchorage already weakened by tipping movements, one would expect that it might give way readily.

In further comment on intermaxillary traction Dr. Tweed gives the injunction that "the intermaxillary elastics should not create too much pull." The question naturally arises as to what constitutes too much pull. Does this mean one elastic or more; large elastic or small; election band or rubber dam? The instructions are too vague to be helpful.

The last portion of the paper that we would like to discuss is that which begins:

"Occasionally after the establishment of a normal mesiodistal jaw relationship and proper cuspal relations, an examination of the front and profile will disclose lack of vertical development, or a bite that is closed even though the incisors are edge to edge."

One has difficulty in understanding parts of this. A lack of vertical development one can visualize, but just what sort of condition is a closed bite with edge to edge incisors? And the treatment to overcome the condition is even more curious:

"A bite plane is made in such a manner that only the upper incisors, both centrals, engage the bite-plane and hold the opposing buccal segments of teeth approximately 1/8 inch apart.

*The italics are the author's.

* * * * *

"A large intermaxillary elastic is hooked around the distal ends of the arches, which have been turned up in the maxillary arch behind the molars and down in the mandibular arch. The elastic is brought forward and hooked around the mesial ends of the segments of the arches, both above and below, to form an oblong figure, with up and down pull in the molar and cuspid regions of the buccal segments of each arch. With the bite plane in place, the buccal segments on each side are drawn together at the rate of ⅛ inch each two months."

Now if this phase of treatment began with incisors that were edge to edge, it follows that the bite plane would have to separate them by more than ⅛ inch if the buccal teeth were to be separated by this amount. The paper merely states that "After the bite plane is removed the space between the upper and lower incisor segments will be from ⅛ to ¼ inch, depending on the amount of vertical development that has been accomplished." Or, one might add, depending on how much the incisors have been depressed.

And now elastics are employed to pull the upper and lower incisors together, using as resistance the buccal teeth that have supposedly just been elevated. One could ask in all fairness, just what has been accomplished? Have the buccal segments been elevated or the incisors depressed in the first stage and have the incisors been elevated or the buccal segments depressed in the second? Or is it possible that after all of this manipulation there has been anything accomplished other than a mere leveling off of the occlusal plane? In brief, has any vertical development been induced? There is no proof of it given in the paper.

In closing, we wish to say that we have tried to meet Dr. Tweed's request for criticism of his technique and we have tried to make this criticism constructive by indicating our own methods as they were taught us by Dr. Angle. We feel certain that a return to fundamental principles will convincingly prove that these additional operations advocated by Dr. Tweed are not only valueless but that they constitute further complications in matters already sufficiently difficult.

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