



RECIPROCAL ORTHODONTIC PHENOMENA*

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Although this contribution is particularly related to the Begg light round arch wire appliance, the basic theme is also applicable to other full banding techniques.

Strang¹ defines a particular form of reciprocal action in the following terms:

"... the form of anchorage that is most universally employed and which is not really anchorage from the viewpoint of fixation, but rather is equalized, controlled and balanced tooth movement, is obtained by a reciprocal action between various teeth or groups of teeth in which the movements desired are more or less in opposite directions so that the force and reaction law can be applied to advantage and universal displacement obtained".

Newton's Third Law relating action to an equal and opposite reaction requires recognition with respect to a biological system exposed to orthodontic treatment. Under these circumstances every applied force, whether it be intention or unintentional, results in an equivalent reaction being transmitted to locations elsewhere within the appliance itself, and so to the investing tissues of the affected dental units. An understanding of these reciprocal phenomena by the orthodontist can be applied to improve the efficiency of his treatment in a manner beneficial to both the patient and himself. Thus it is possible to utilise reciprocal or mutual interactions between various teeth, or groups of teeth, in which the desired movements occur in a balanced and co-ordinated manner.

Pertinent to any consideration of reciprocal tooth movement is a knowledge of recent research directed towards a more complete understanding of the periodontal response. We all appreciate that momentary pressures developed by the act of mastication are of a different physiological significance to the prolonged pres-

ures induced by orthodontic appliances. It has been suggested that under orthodontic conditions the periodontal response involves various physical phenomena such as hemodynamic damping effects and viscoelasticity².

The once classical concepts of dynamic and anatomic homogeneity of the periodontal membrane^{3,4} are no longer acceptable. Recent investigations suggest that the periodontal tissues are involved in several different mechanisms of tooth support⁵ and that these mechanisms obviously play significant roles in response to orthodontic stimulation. As yet, we are unable to accurately analyse the respective effects of deliberately produced variations in orthodontic response such as reciprocal force application, or incisor intrusion, in terms of the differential systems operating through the morphological components of the periodontal membrane. Thus, for the moment, clinical procedures still remain based upon essentially empirical experiences of the variety to be outlined in this presentation.

Force application in orthodontics when administered with an appreciation of its reciprocal effects, can be efficiently harnessed to produce corresponding tooth reactions of a beneficial nature elsewhere in the dental arches. However, failure to appreciate the manner of these reactions and so maintain all tooth movements in a state of balance may result in a rapid deterioration in appliance efficiency, loss of treatment control and ineffectual correction of the malocclusion. Even worse will be the sad disillusionment which can affect both patient and operator alike.

Any clinician, before he embarks upon the use of the Begg technique, must possess the

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facility to think objectively and be able to analyse in his own mind the purpose behind every manipulation of the light wire appliance and its reciprocal consequences. Should he feel unable to meet the demands of such a disciplined technique, then it is desirable that he direct his interest to other forms of mechanotherapy since the Begg technique is undoubtedly a methodology for orthodontists possessing a broad vision of their specialty.

The efficiency of the light wire technique is dependent upon the application of optimal value reciprocal forces. When applied in the correct sequence, they produce a balanced flow of continual tooth movements during all stages of treatment. Therefore, the operator needs to develop the facility to evaluate the relative contributions of the various activated orthodontic components to future tooth movements. A simple example of a reciprocally activated component is seen in the use of a Class II elastic stretched between the maxillary and mandibular dental arches.

Some of the reciprocal actions of an appliance result from the physical properties of the arch wire itself, the type of attachments used on the bands, and the manner in which the arch wire is manipulated during construction. Additional reciprocal effects are derived from the use of auxiliary components, the method of engagement of the arch wire in the brackets and the utilization of rubber elastic forces to move single or multiple tooth units.

It is intended to devote the present paper to a consideration of some of the reciprocal factors developed during the first and third stages of treatment. Particular emphasis will be directed to reactions produced by the activation of arch wires and elastic forces.

FIRST STAGE OF TREATMENT

Immediately following the placement and activation of the initial set of arch wires the teeth are subjected to a number of simultaneous biomechanical effects. The resultant orthodontic movements may involve various combinations of intrusion, extrusion, tipping, bodily movement, labio-lingual repositioning, rotation and bucco-lingual changes in location.

Correctly constructed arch wires will simultaneously initiate movements that will result in symmetrical and harmonious dental arch form. Inadequately prepared appliances will produce a variety of unfavourable orthodontic reactions including closure of the bite, narrow-

ing of the inter-canine width and loss of anchorage control.

The examples to be outlined will serve to illustrate the need to develop an understanding of the subtle reciprocal effects associated with the use of full banding techniques, particularly where round section arch wires are employed.

Reciprocal anchorage effects

A survey of current literature on the light wire technique soon makes it apparent that the anchorage bend is evaluated essentially in terms of its intrusive effect upon the incisors, and also its reciprocal role in maintaining the molar teeth in an upright position for purposes of anchorage stability. A critical evaluation of arch wire function suggests that this supposition rather over-simplifies the true situation. Consider the following example. We observe that when the arch wire is placed in the anchor molar buccal tube there is a "Newtonian" reactive force in the anterior segment tending to intrude the anterior teeth. But what is almost universally overlooked is the fact that when the arch wire is pinned into the anterior brackets, the freed distal ends of the arch provide clear evidence of their ability to provide a reciprocal intrusive action on the molar tooth. This feature is shown diagrammatically in Figure 1.

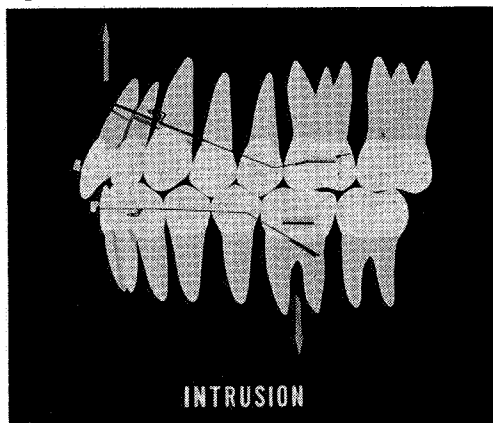


Figure 1—Separate intrusive components of a reciprocating arch wire system, which becomes operative when each arch wire is correctly engaged.

Therefore, it can be readily appreciated that any extrusive tendency of correctly worn Class II elastics is significantly counteracted by this dual reciprocal arch wire factor acting along its distal extremities.

Type and location of anchorage bends

I have no hesitation in nominating the an-

chorage bend as that particular component of the Begg technique which makes the major contribution to either success or failure in attaining treatment objectives. One's ability to handle this appliance with clinical competence is dependent on the possession of a full appreciation and insight into the reciprocal force action originating from these bends.

During any phase of treatment, incorrect methods of arch wire correlation can result in reciprocal effects producing lack of dental arch conformity, undesirable regions of expansion or contraction, as well as a reduction in anchor unit control. A classical example of mistaken therapy with this appliance has been the use of an omega loop as a substitute for the simple anchorage bend just mesial to the buccal tube. Unfortunately, as many operators have found to their dismay, prolonged use of this loop variation results in efficient but unexpected rotation and lingual displacement of the anchor teeth. This loop modification significantly reduces anchorage potential.

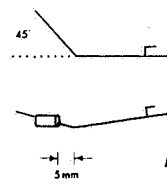
For any specific degree of anchorage bend, the actual location of the bend mesial to the buccal tube exerts a critical effect on incisor as well as molar intrusion. The further the bend is positioned mesially the smaller is the anterior intrusive force and, conversely, the reciprocal molar component of intrusion will be diminished. You will therefore appreciate why placement of the anchorage bend opposite the position of the first premolar results in failure to open the bite. Under these circumstances no significant reciprocal intrusive force can be obtained due to the mechanics of such an arch form, and the inherent flexibility of the arch wire itself.

The degree of anchorage bend

An understanding of the need for well accentuated anchorage bends, particularly to counteract Class II elastic effects on the incisor region, is all too frequently overlooked. By the knowledgeable use of anchorage resistance, incisor segment intrusion and the ability to maintain the anchor molars in an upright axial relationship are enhanced as the angle of the bend is increased. There is a limit, of course! The degree of anchorage bend has an important influence on "toe-in" and the maintenance of correct bucco-lingual arch dimensions.

The interdependence of reciprocal "location" and "degree" factors is summarised in Figure 2.

ANCHORAGE BENDS



	3 mm	5 mm	8 mm
	grams		
30°	35	30	15
45°	50	40	25
60°	70	55	40

Figure 2—Significant alterations in the anterior intrusive forces are produced by variation in the anchorage bends.

"Toe-in"

This is a further example of arch wire reactivity which demands our attention.

The incorporation of "toe-in" as a final phase of arch wire construction results in a dramatic interdependence between it and anchorage bend influences, since both originate from the same location on the arch wire. Either excess "toe-in" or extreme anchorage bends can cause molar rotation as an undesirable feature of treatment. The former rotates by direct action and the latter as an indirect effect of arch wire distortion. Lingual displacement of the molars is generally associated with these undesirable rotations and only serves to complicate the situation. As one can readily appreciate from sufficient typodont experience, the ability to show "finesse" in controlling the reciprocal interaction between "toe-in" and anchorage bends results in more effective anchorage stability, the prevention of molar rotations, maintenance of correct inter-molar width, and serves to counteract the rotational influence of elastic wearing.

The rapidity with which molar rotation can be produced by lack of round wire control suggests that the anatomical arrangement of the

tooth investing tissues is more susceptible to the rotational effect of excess "toe-in" than it is to the intrusive influence of "anchorage bends".

Elastic Forces

Rubber elastic forces make an essential contribution to treatment provided their ability to bring about tooth relocation is utilised in a synergistic manner to enhance the system of reciprocal actions developed within the arch wires. For example, the nature of bite opening produced during therapy is particularly related to the combined interaction of the anchorage bend and the Class II elastic. Incorrect treatment serves to open the bite by lower molar extrusion. Correct light wire therapy will not only open the bite by intruding incisor teeth, but it can also be manipulated to depress anchor molar teeth.

In the construction of a maxillary appliance the appropriate anchorage bends will serve to store and deliver forces according to the particular manner in which the arch wire is manipulated. It will be quite apparent that one of the reciprocal vectors must involve the continual intrusion of the anterior tooth segment to counteract the extrusive tendency of Class II elastics. However, with but few exceptions, the basic principles of reciprocity originating from the use of round wires and elastics are similar in both arches.

Of particular importance to us is the manner in which rubber force activation can influence a change in the types of tooth movement produced during treatment. While the maxillary incisor segment is being aligned and retracted during early treatment, the axis of rotation must be continuously variable as the relative tooth positions in the maxillary alveolus are altered. When the intermaxillary elastic force is not excessive the rotational axis of procumbent teeth is adjacent to their apices. Should the rubber force be excessive, the axis of rotation is relocated in the region of the lingual alveolar crest with the result that undesirable labial movement of the root apex occurs. Therefore, the correct manipulation of elastic bands is of primary importance to the successful completion of every phase of treatment.

Although the lower incisors (except in Class III malocclusions) are not initially activated with elastics like the maxillary teeth, they respond to the reciprocal action of the mandibular arch wire with a characteristic lingual bodily movement which surprises operators un-

familiar with light wire reactivity. The addition of horizontal elastics to the lower arch wire during the first stage of treatment will only serve to destroy this reciprocal action of bodily tooth repositioning.

THIRD STAGE OF TREATMENT

Auxiliary Components

Auxiliary components can also contribute unique effects of reciprocity as any operator will recall who has failed to ligate root tipping springs to the base arch. However, despite the examples already presented, it is the incisal torquing appliance which illustrates the finesse of reciprocal variation in its most interesting form. The application of incisal root torque invariably results in a number of reciprocal consequences, one of the most characteristic being the tendency to progressive buccal expansion along the distal extremity of the arch wire. In order to balance the expansion vectors of the system, a knowledge of the appropriate reciprocal compensations during arch wire preparation is essential if one is to achieve significant buccal segment control.

Torquing Incisor Teeth

There are several published varieties of light wire torquing mechanisms. Each type requires quite individual modifications to the appliance in order to balance the reciprocal activity that they generate. For example, the Kichon auxiliary necessitates a unique method of arch wire compensation to maintain arch contour and prevent closure of the bite. Similarly, another type of torquing appliance will necessitate an altogether different method of arch wire compensation, as seen in Figure 3.

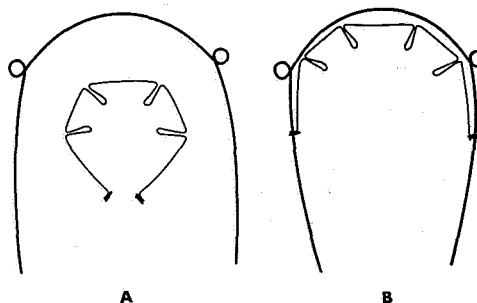


Figure 3—(A) The separate components of an incisal torquing appliance.
(B) Assembly of the mechanism produces a reciprocal change in the form of the main arch wire.

For the sake of convenience it is frequently rationalised that the mere antero-posterior relocation of incisor tooth segments will provide

adequate post-retention stability and acceptable aesthetics. In fact, it is the ability to provide the balanced reciprocal combination between tooth torque and antero-posterior repositioning which serves to differentiate standards of orthodontic attainment. Surely it is unrealistic for us to continue to formulate treatment plans based on the false premise that significant and controlled tooth torque is not available with contemporary mechanotherapy, Figure 4.

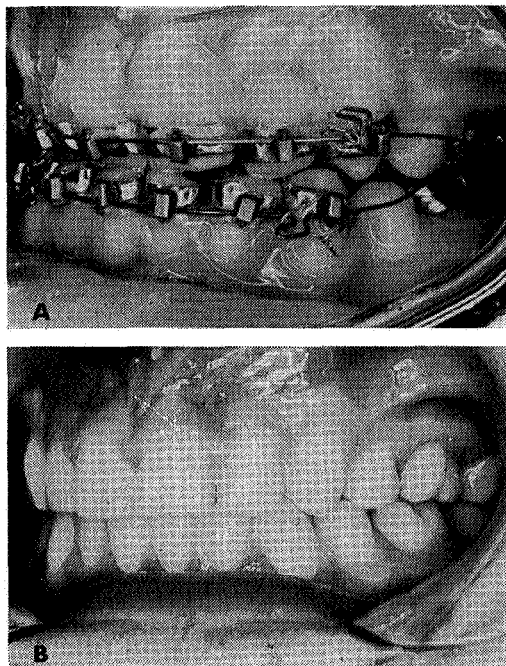


Figure 4—(A) Incisal tooth relationships as seen at the conclusion of the second stage of treatment.
(B) The same patient 1½ years after the appliances were removed.
Progress records of this case were presented in a previous publication.⁷

It is during the third stage of treatment with the light wire appliance that the essential role of elastics, as components of a reciprocating force system, is seen to maximum advantage. Throughout this Stage the discretionary use of Class II elastics is employed as the intermediate means to balance the reciprocal forces generated by the appliance within the

maxillary arch against those developed in the mandibular dental arch. As a result, the antero-posterior tooth positions can be maintained in an over-treated relationship until all bands are removed, by virtue of the creation and maintenance of a slight open bite in the incisor area.

CONCLUSION

While this text has only touched upon some of the more obvious areas of mechanical reciprocity, the importance of these generated force systems will be apparent to those colleagues familiar with the time-consuming practice of detailed finishing with full banded appliances. The present paper outlines some of the predominant reciprocal interactions associated with the Begg technique in order to emphasize a few of the subtle aspects underlying its applied biomechanics. The inherent benefits of reciprocal systems can only be attained when the light wire technique is employed strictly in accordance with the demands of each stage of treatment.

In closing I would like to offer you the following definition.

“Reciprocal force control is force application tempered with intelligence and understanding”.

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