Molar Control
Part 2

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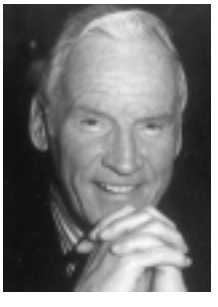
The off-center bends and their variations have been discussed and illustrated. It is now time to see just how these bends will be used to control molar positioning. It should be emphasized that these bends are not to be placed until full bracket alignment has been attained. This may seem like a contradiction, since the molars would not require repositioning if all brackets and tubes were in perfect alignment. Keep in mind that buccal and lingual displacements may occur due to the vertical forces already discussed, but bracket and tube alignment are not necessarily affected. Molar rotations may occur following original bracket alignment or may exist from the onset. To be more specific, it should be said that brackets should be leveled and aligned, while molar tubes need to be leveled, but not necessarily aligned. In short, level and align all brackets, and level the molar tubes.

Archwires in Use

Following bracket alignment, I use only two different types of archwires. With .022" × .028" slot sizes, .020" round archwires will not fill the slots. This will prove to have advantages as described later. A “step” archwire is used whenever it is desirable to increase the arch length (Fig. 2-1). A “wraparound” archwire is used any time arch length is to be reduced (Fig. 2-2). Either wire may be used if the existing arch length is to remain unchanged. Since increases



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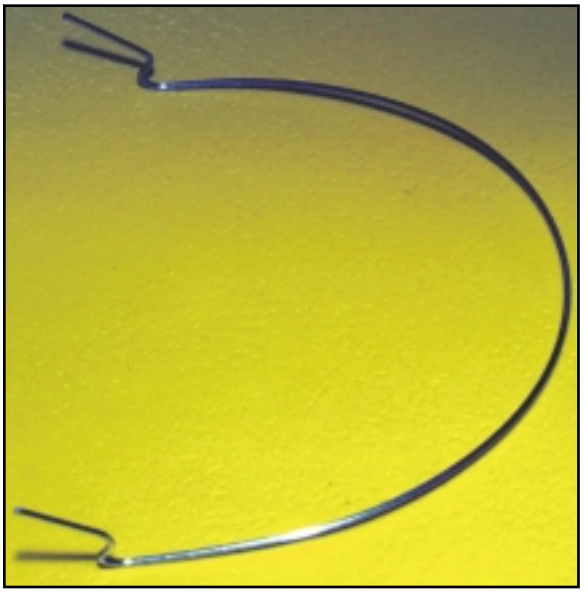

Fig. 2-1 Step archwire.

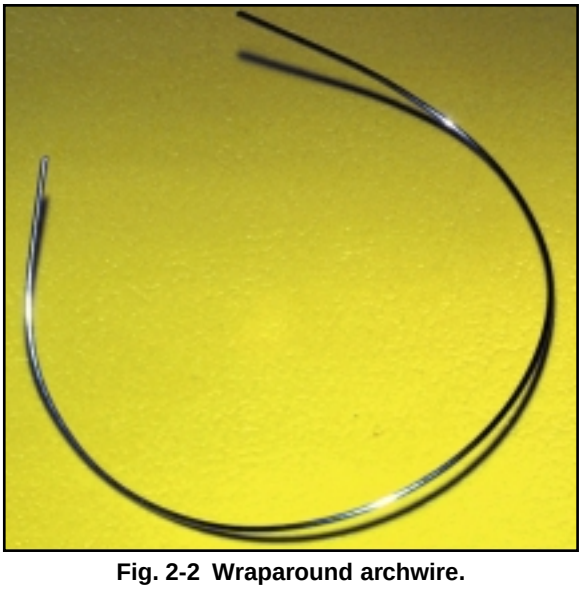

Fig. 2-2 Wraparound archwire.

and decreases in arch length are not subjects to be discussed at this time, molar-control bends will be presented with the knowledge that either wire may be in place at the time. The wire in use does not affect the placement of molar-control bends.

Partial Appliance or Equivalent

The appliance in place will consist of first molar bands and anterior brackets. Sometimes there will be only four incisor brackets present, while at other times the cuspid brackets will be in place during orthodontic treatment. Brackets are not bonded for the purpose of placing molar-control bends. The molar-control bends are placed for a specific purpose, regardless of whether the appliance happens to be a 2×4 or 2×6.

The orthodontist might be in the midst of correcting overbite with a 2×4 when the vertical forces acting through the molar tubes produce evidence of molar displacement. It is likewise possible that a 2×6 would be in use at the time. Whatever the situation may be, brackets are not added or removed to enable the orthodontist to apply the molar control concept. If a full appliance happens to be present, bracket removal will not be necessary. By avoiding ligation of the archwire to the bicuspid brackets, a partial appliance has, in effect, been created for the application of horizontal forces, because the molars will be free to move buccally or lingually, carrying the archwire with them.

If all teeth were ligated during the use of molar-control bends, the desired force systems would not be created, as each bend placed would become almost centered in relation to the adjacent brackets. The primary force system will take effect at the brackets or tubes adjacent to the bend. Ultimately, other teeth will be affected by the secondary force system, but molar positioning will have taken place prior to that time.

Sequence of Bend Placement

To apply the molar-control bends in a manner that will maximize the use of forces and moments produced, the sequence of bend placement will be critically important. This sequence cannot be violated at any time, as the desired force systems would be upset.

Each time the orthodontist looks at the teeth from the occlusal view, two questions need to be asked: First, "Do the molars need to be rotated?" Second, "Are buccolingual displacements present?" Each answer will be dealt with in that exact order.

If the molars do require rotational moments, either a toe-in or a toe-out bend will be required for each molar. These represent the short sections of an off-center bend. In a full strap-up there would, in effect, be no short sections, as such determinations are made by relating the bend to the bracket and tube adjacent to that bend. If the molar problem exists in only a single quadrant, then the correctional moment will be applied only to the molar in that quadrant. If the rotations happen to be different in each quadrant, then the appropriate bend will be placed for each correction.

Only after the necessary toe-in or toe-out bends have been placed will the operator continue by addressing displacements. If the molar in a given quadrant requires buccal movement (lingually displaced), an out-bend may be placed. This is not to say that an out-bend must necessarily be placed, as the toe-in or toe-out bend may have already provided the horizontal force necessary to take care of the displacement problem. If only lingual movement of the molar is required, an in-bend will be placed.

These bends and their locations will be made clear as we proceed with their application. Only the pure off-center bends will be discussed initially. They consist of the toe-ins and toe-outs associated with the short sections and the in-bends and out-bends associated with the long sections of the pure off-center bends.

Off-Center Bends

It will be seen that all bends used for molar control are off-center bends (Fig. 2-3). Some will be used later in combination with others. For

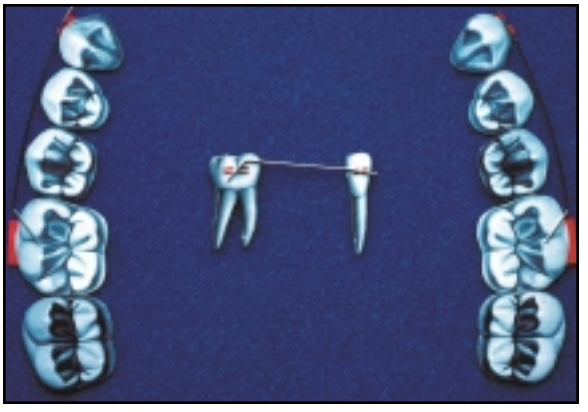

Fig. 2-3 Occlusal and sagittal views of off-center bend.

now, only single off-center bends will be considered.

The section pertaining to the molar will be recognized as the short or long section of the off-center bend. This will make it relatively simple to identify the forces and moments of concern. In all illustrations presented, the second molars will be assumed to require no movement for any reason whatsoever and will therefore remain unbanded. This presents the challenge to the orthodontist of maintaining central-groove alignment between the first and second molars. To help the reader realize that off-center bends are no different in the occlusal plane than in the sagittal plane, Figure 2-3 illustrates the molar tipback bend. The forces and moments may be described in different terminology, but their presence is determined in the same manner. Central-groove alignment cannot be achieved unless the orthodontist is capable of either maintaining such alignment from the beginning or restoring the first molars to their original or correct position later. In any case, this is a challenge that can successfully be met by following the procedures as presented. The rewards in terms of effort and time saved throughout one's lifetime of practice can be immeasurable.

The In-Bend

In Figure 2-4, there is an obvious first molar displacement. The view involves one quadrant of a continuous archwire. Following the sequence mandated, it must first be asked whether the molar is rotated. Since the answer is clearly negative, no rotational bends are necessary.

It is time then to move to the second question pertaining to displacements. We are already halfway to the solution, and yet we have barely begun. It is clear that the molar has been displaced toward the buccal. Since the question of molar displacements involves only the application of in-bends or out-bends, it is clear that an in-bend is the bend of choice.

Because this in-bend represents the long section of the off-center bend, it points in the direction of the force produced. As explained earlier, a lingual force acting through the molar tube produces a lingual crown moment. A tooth that has tipped to the buccal is now permitted to tip to the lingual. A vertical force capable of producing the original buccal crown moment, which resulted in the buccal displacement, is now overcome. The lingual or horizontal force now present creates a larger moment for correction than the original moment, which resulted in the displacement. From this point, reference will be made only to the horizontal forces acting on molars, as we will know that such forces result in crown moments.

Locating the Bends

The in-bends or out-bends are always placed in the embrasures between the first bicuspids and the cuspids, regardless of whether the appliance is a 2×4 or 2×6. In fact, if the cuspids have not yet begun their eruption, the bends will be placed where the embrasures would exist if the cuspids were in place. This will be shown throughout the clinical illustrations. Experience has proven this to be the best approach, because it can be applied to all conditions. In this series, every effort has been made to provide a method that can be repeated many times over, every day, on every patient requiring such movement. When an action is repeated with such frequency in the same manner, it passes into the subconscious,

where it is available for immediate and automatic recall. This is no different from learning the spelling of difficult words, the alphabet, multiplication tables, languages, or any other subject that requires repetition in words or actions. Such learning is referred to as "spaced repetition".

Remember, there will be an equal and opposite force acting on the cuspid, but this is the area of rigidity previously described, in which response is quite negligible. The molar effectively responds because of its location in a resilient section of the archwire. Figure 2-4 also contains a smaller illustration of the continuous archwire and its configuration following activation and removal. Keep in mind that all activations are done intraorally with a Tweed-loop plier. The operator will not see the resulting archwire configuration until removal is indicated. Of course, during the initial periods of learning, it would be wise to activate and then remove the archwire to get an immediate idea of what configuration is being created. Eventually, there will be configurations far from what most individuals would imagine.

The Out-Bend

Moving next to Figure 2-5, the same basic problem presented in Figure 2-4 is repeated with an obvious molar displacement in the opposite direction. Since there are no rotations present, the first question pertaining to rotations requires no action. The second question pertaining to displacements requires a buccal force. An out-bend is the bend of choice. Note the archwire configuration upon removal. When only in-bends or out-bends are required, it becomes so obvious as to

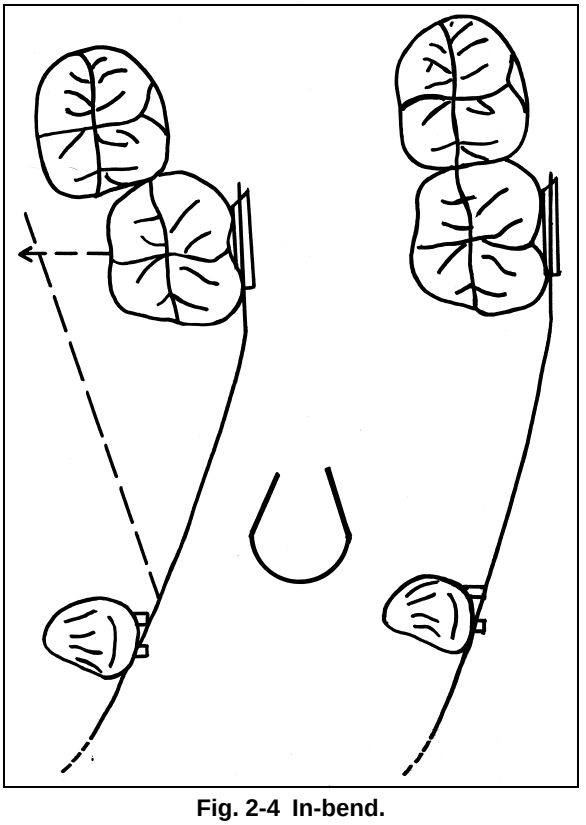

Fig. 2-4 In-bend.

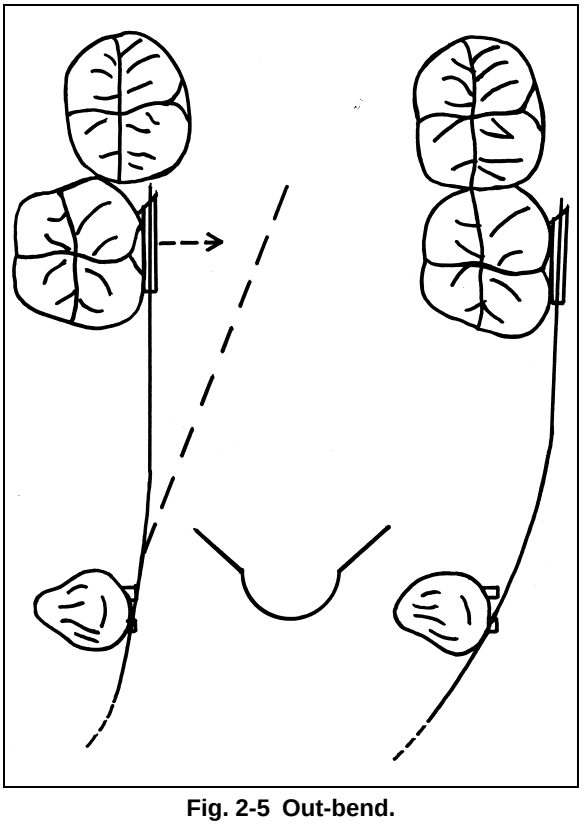

Fig. 2-5 Out-bend.

seem almost too easy. Gradually, the problems will be made more difficult, but the solutions will continue to be met with relative ease.

The Toe-In Bend

Figure 2-6 illustrates the toe-in bend. Unlike the in-bends and out-bends, which represented the long sections of the off-center bends, the short sections are now applied to the molars. The bends are located just mesial to the molar tubes. Since the first question asked pertains to rotations, it is obvious that the rotation illustrated requires the placement of a toe-in bend for the desired moment. Always keep in mind that the moment will be accompanied by a horizontal force, which in this case is a buccal force. Remember the off-center rule. The short section points opposite to the force produced. Since the short section points to the lingual, the force must be to the buccal. This is no different from the sagittal view of the tipback molar bend in Figure 2-3, where the short section points apically and the corresponding force is extrusive. As with the in-bends and out-bends, equal and opposite forces are produced at the cuspids, but do not result in significant response due to the rigidity of the anterior segment.

Question No. 2 refers to molar displacement. The molar definitely requires buccal movement, but the buccal force associated with the rotational moment is already present. Therefore, no further action need be taken. Note the archwire configuration upon removal.

The Toe-Out Bend

Figure 2-7 illustrates the toe-out bend. The first question deals with rotation, which is obvi-

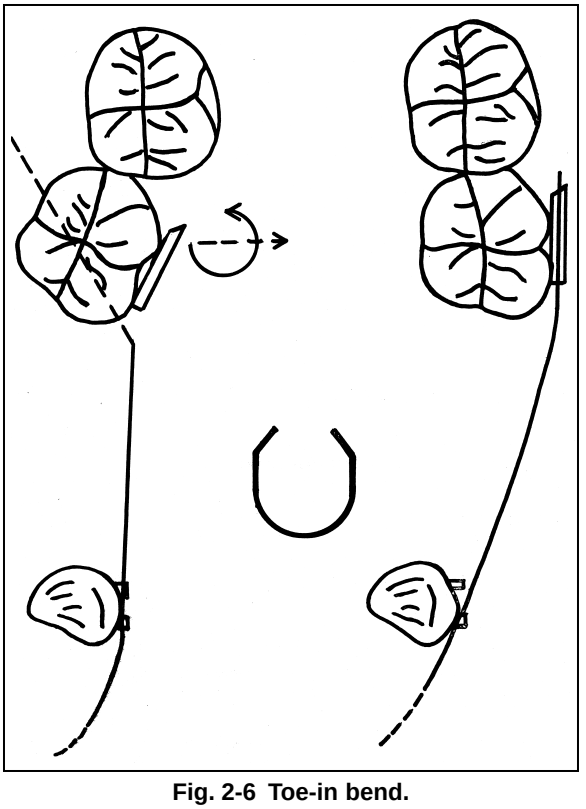

Fig. 2-6 Toe-in bend.

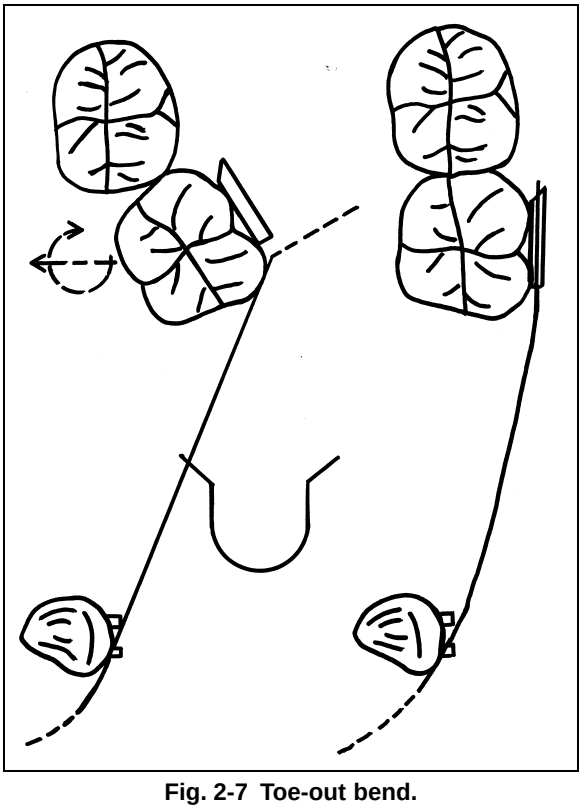

Fig. 2-7 Toe-out bend.

ously present. There is little doubt whether a toe-in or toe-out bend is indicated. The toe-out bend delivers the necessary moment to correct the molar rotation, but it must again be remembered that a horizontal force is present, which in this case is toward the lingual.

The second question in the sequence pertains to molar displacement. It is obvious the molar is displaced toward the buccal. But since a lingual force, necessary to correct the buccal displacement, is already present, no further action is required. Note the archwire configuration upon removal.

Clinical Application

Having presented as much detail as necessary for molar control, it is time to see just how these off-center bends, when applied as directed, will result in the desired tooth movement. It cannot be overemphasized that all decisions must be made from centric relation and not centric occlusion. There may be molar crossbites that appear to be unilateral when they are actually bilateral.

During the initial examination, the teeth are kept out of occlusion for a period of time to allow for the loss of proprioception. After several trial closures, without the teeth making contact, the centric arc is established. Then the teeth are allowed to make initial contact, very lightly, at which time an evaluation is made for treatment needs. Closure must be on the centric arc to make logical decisions regarding required tooth movement.

Obviously, if we fail to recognize bilateral displacements of teeth and, instead, treat them as unilateral displacements, we will create a deviation on closure following treatment that will eventually produce TMJ disorders. This is not the time or place to be discussing these matters in any detail, as the only intent is to present the mechanics for the needed tooth movement. Required tooth movement cannot be determined by simply having the patient close into centric occlusion and by disregarding the interferences that may result in mandibular displacement laterally and/or anteroposteriorly.

The Neutral Zone

The term “neutral zone” has been used in a meaningful way by Dr. Peter Dawson. Throughout this series, it will refer to the state of balance shared by all teeth in a normal functional occlusion when related to the surrounding muscle environment. Although the teeth cannot always be placed into such a balanced state, we can at least determine to what degree they have been displaced from the neutral zone.

It should be realized that a malocclusion is in a state of equilibrium. The teeth will tend to stay where they are because of function, habits, and muscle environment, but this is not the normal state. Considering all the debate that has taken place regarding expansion and induced growth, I choose not to expand cuspids beyond their normal limits and to treat posterior teeth to their natural widths as determined by function and normal muscle environment. As for the anterior limits, it simply is not always possible to place the incisors into the neutral zone. Sometimes extractions result in the removal of too much tooth material, while at other times nonextraction treatment leaves an excess of tooth material. Interproximal reduction cannot always solve the problem. The result is that there will be patients whose incisors lie outside the neutral zone. Even in those cases, however, it is important to remove the archwires periodically. While the teeth are in a mobile state, they will quickly move in the direction of the neutral zone.

When the anteroposterior limits of the neutral zone are ascertained, it can then be determined whether the incisors can be placed within the neutral zone. If not, it can at least be determined how close they can be placed to the neutral zone. At least the orthodontist will learn whether interproximal reduction will suffice if the teeth are slightly forward, or if the teeth must be recognized as being unstable in their existing positions.

It is better for the patient to see and experience the effects of instability during treatment than following treatment, when it is then too late. Any orthodontist knows that explanations pro-

vided to the patient after relapse occurs tend to be perceived as excuses. Informing the patient of what to expect in terms of stability or instability can best be handled early in treatment during archwire removal. The patient is generally excited about the changes already being experienced and has not yet seen the "perfect result". This is an ideal time to inform the patient of his or her responsibilities during retention.

Attempting to determine the neutral zone for each patient by archwire removal has proven to be one of the most valuable experiences gained in my entire life's practice of orthodontics. It is difficult to imagine how a cephalometric headfilm can be expected to provide the answers, even with today's sophisticated computer technology. The profession has been looking for a treatment position that works for each individual patient, and it seems to make sense that the information is available and has been for some time. Every individual contains all the information that defines the forces of occlusion, habits, duration, and so on. Why not remove the archwires and listen to what the patient is saying? It will be one of the most rewarding and meaningful encounters of your life.

Case 1

The first patient shows bilateral mesiolingual rotations of the maxillary molars, which are also lingually displaced on each side (Fig. 2-8). This is not an uncommon event for teeth that have been permitted to drift mesially over a period of time.

Toe-in bends have been placed to provide the necessary moments for rotational correction. Including the second bicuspid brackets would result in a center bend with an entirely different force system. By not engaging the archwire into the bicuspid brackets, however, the bend becomes distinctly off-centered and permits the application of molar-control bends in a routine manner. There are now short sections at each end of the archwire, and therefore buccal forces at each molar tube. This means that the second question pertaining to molar displacement requires no action. The necessary buccal forces are already present.

In the remaining cases, it will not be neces-

Fig. 2-8 Case 1. A. Mesiolingual rotations of first molars and lingual displacements. B. Correction obtained by avoiding inclusion of second bicuspid brackets. This results in off-center bend mesial to each first molar, so that each toe-in bend produces corrective moment and buccal force.

sary to keep repeating the two questions relative to rotations and displacements. Instead, simply remember that from this point forward, all bends applied will be for "rotations first and displacements second".

Case 2

The next patient has both a mesiolingual rotation of the upper right first molar and a lingual displacement (Fig. 2-9). The problem is primarily unilateral, as determined by closure on the centric arc. It has been said by some that all unilateral crossbites are associated with mandibular shifts and are really bilateral crossbites in disguise. My only disagreement with that statement is in the use of the word "all". Many crossbites are more severe on one side than on the other when evaluated by closure on the centric arc. It is true that the strictly unilateral crossbite is uncommon, but it does exist.

A toe-in bend, on the right side only, has overcorrected the first molar rotation. The tooth has moved buccally as evidenced by the overjet, while no undesirable reciprocal effects have occurred on the patient's left side. This is because the primary effect takes place on the teeth adjacent to the bends.

Case 3

This patient was seen by several orthodontists who recommended palate-splitting appliances. Without attempting to debate which type of appliance could best resolve the bilateral constriction of the maxillary arch, we can take note of certain features (Fig. 2-10).

Effective buccal movement of the bicuspids can occur by use of ligature ties. In fact, the buccal force provided results in greater bodily movement than would take place with the use of brackets, because the applied force lies closer to the center of resistance. It is important not to bracket the bicuspids, as this would not permit the use of the off-center bend with its desirable force system.

First of all, the buccal teeth show lingual crown inclinations. Because the teeth in the buccal segments are contained within the alveolar process, such tooth movement is under the control of the orthodontist. If it can be visualized beforehand that uprighting buccal teeth will provide the proper correction in width while maintaining an acceptable inclination, it seems reasonable to approach treatment with this in mind. Rotation of the first molars provides a buccal force through these crowns. It can be seen that the teeth in the buccal segment have been left

Fig. 2-9 Case 2. A. Mesiolingual rotation of upper right first molar and lingual displacement. B. Correction from use of toe-in bend on right side only. Note that left side shows no reciprocal effects. Reciprocal effects occur primarily on teeth immediately adjacent to bend.

behind. If bicuspid rotations do not exist, the teeth may be directly ligated to the archwire and moved rather rapidly toward the buccal.

Since archwires are removed from all patients periodically to evaluate the neutral zone, and never for less than six weeks at a time, the degree of stability or instability may be determined for each patient before removing appliances.

If the teeth have been placed so that they are no longer in harmony with their functional environment, undesirable movements will occur. It is better to determine a harmonious relationship during treatment than to discover, after the loss of a retainer, that the case has fallen into relapse.

Although this case could have used more overbite, the existing relationship maintained itself following archwire removal. The upper left cuspid required a finger spring within the retain-

Fig. 2-10 Case 3. A. Lingual crown inclinations seen in buccal segments, although occlusal view leaves impression of deep palatal vault. Uprighting maxillary teeth will increase maxillary width while eliminating perception of deep vault. B. Upper molar correction obtained through use of toe-in bends. C. Bicuspids tied to archwire with ligature wire. D. Effective tooth movement using ligature ties. E. Several years following treatment.

er for slight labial movement. Experience has shown that if the vertical relationship of the incisors maintains itself during the period of archwire removal, within about a year there is usually an increase in the overbite of one-half to one millimeter, and more thereafter. This may sound insignificant, but the change is in a desirable direction and occurs during natural function.

Case 4

The patient has mesiolingual rotations of both maxillary molars in addition to lingual displacements (Fig. 2-11). Toe-in bends provide the moments necessary to correct the rotations, and the buccal forces accompanying the moments provide for the necessary buccal movement of the molars.

After the maxillary molars have been corrected, the archwire is sectioned to leave only an anterior segment, with the molars free to function in an unrestrained manner. This presents an opportunity for checking the stability of the posterior crossbite correction while continuing to overcorrect incisor displacements. The case is shown later with the molars maintaining the corrections.

Case 5

The occlusal view reveals severe mesiolingual rotations in addition to lingually displaced molars (Fig. 2-12). Toe-in bends are used to correct rotational moments and provide the buccal forces needed to position the maxillary molars properly.

Because of the initial rotations, the first archwire does not require toe-in bends, as the force system is provided from the malocclusion itself. A straight wire will provide the correct initial forces and moments, and the toe-in bends may be added later. If the rotations are so severe as not to accept an .020" archwire, however, a smaller wire may be used initially.

This case is particularly interesting because of the vertical forces involved in correcting overbite. This means there are extrusive forces acting through the molar tubes, producing lingual crown moments on molars that are already displaced toward the lingual. The buccal forces are of the same magnitude, for reasons explained earlier, but because of their greater distances to the center of resistance in each molar, they produce larger moments in the opposite direction of those produced by the extrusive forces on the molars. This is an excellent example of the net

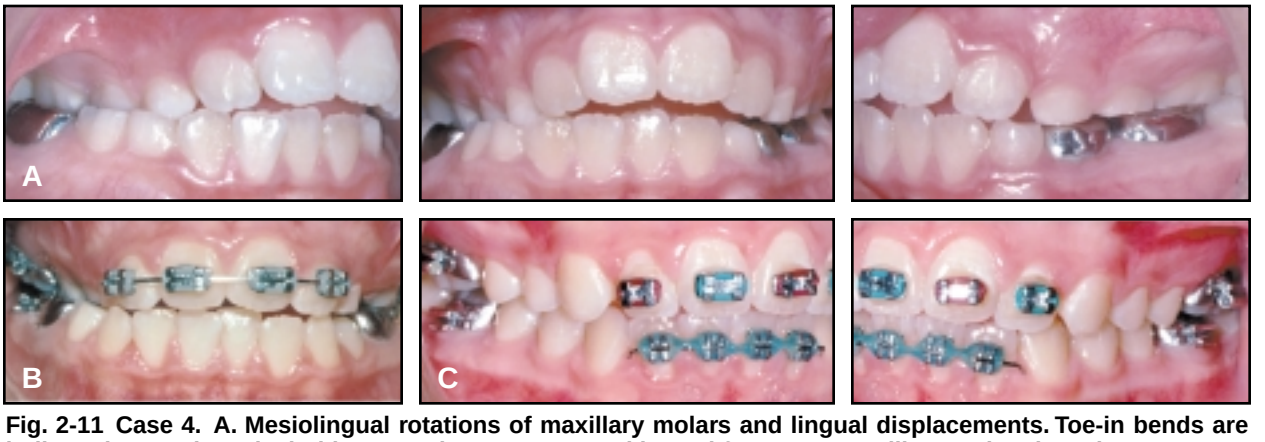

Fig. 2-11 Case 4. A. Mesiolingual rotations of maxillary molars and lingual displacements. Toe-in bends are indicated to produce desirable corrective moments and buccal forces. B. Maxillary molars have been corrected and archwire sectioned, leaving only anterior segment. C. Bicuspids and molars maintaining positions of occlusion without presence of archwires. There will be no question of posterior stability following treatment.

Fig. 2-12 Case 5. A. Upper molar crossbite and molar rotations in deep overbite. B. Initial archwire produces proper moment due to wire-bracket angle produced by malocclusion. C. Sufficient correction of molar rotations enables placement of distinct toe-in bends. These bends provide moments necessary for correcting rotations and buccal forces necessary for crossbite correction. D. Maxillary first molars have been successfully moved buccally, despite lingual crown moments produced on same molars during overbite correction.

moment, described earlier, having the ability to correct a severe problem at the same time an opposing moment would, by itself, tend to make the problem worse (Fig. 2-13).

Note also that the buccal segments show a tendency to move distally during overbite correction. This has to do with differential moments that are produced, but involves another subject altogether.

Conclusion

The off-center bends consist of short and long sections. In this article, treatment has been discussed in which the forces and moments derived at the short section were applied to problems involving molar rotations and displacements. It has been seen that the short section provides both a moment and a force, each of which is useful when applied to the right cases in the appropriate manner. By adhering to the approach of "rotations first and displacements second", the proper force system can be applied to any specific problem.

Next, it will be shown that the same sequential approach for bend placement will result in the use of in-bends and out-bends. These bends represent the long section of the wire and will automatically be derived for those problems requiring nothing more. The approach will be the same for every patient treated, but the force systems will be only those most suitable for each individual problem. Could you ask for more?

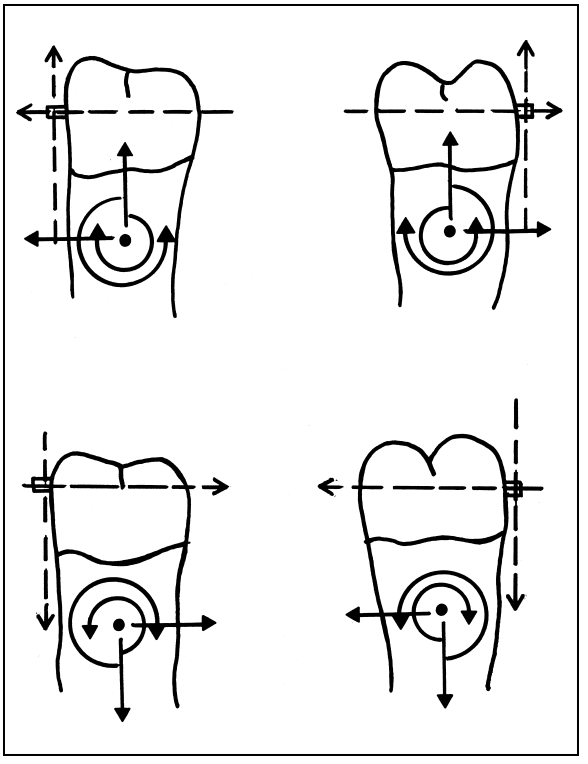

Fig. 2-13 Opposite moments resulting in net moments.

SUGGESTED READING

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2. Dawson, P.E.: *Evaluation, Diagnosis, and Treatment of Occlusal Problems*, Mosby, St. Louis, 1989, pp. 72-84.