Molar Control
Part 1

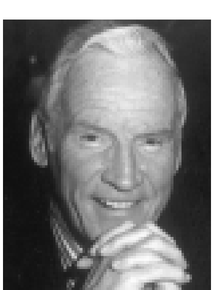
THOMAS F. MULLIGAN, DDS, MSD

This series will offer an easier approach to the control of molar position without requiring an in-depth knowledge of various wire-bracket relationships, which may result in difficult-to-recognize force systems for many clinicians.

When using loop-free archwires, bends can be placed between tubes and/or brackets in such a location that certain wire-bracket angles are created at the adjacent brackets. This affords the choice of various force systems and the opportunity to produce a direct response.

In Figures 1-1 and 1-2, three wire-bracket relationships are shown. Each of these will be applied for molar control in an easy-to-do manner and will prove to be extremely effective for the clinician. In Figure 1-1, the bends have been placed following bracket alignment and the bends then properly located to produce various angles. The first relationship is known as the step or parallel; the second is known as the off-center, and the third is referred to as the center bend (often called a gable bend). These bends are placed intraorally with a Tweed-loop plier, and only after bracket alignment is achieved.

In Figure 1-2, the brackets are shown in an angulated position. This may represent the bracket angles formed by the malocclusion in any plane of space, or by bracket angulation placed within the appliance. It should be noted that the wire-bracket angles are identical to those



Dr. Mulligan is in the private practice of orthodontics at 6843 N. Eighth Ave., Phoenix, AZ 85013. This five-part series is adapted by permission from his book, *Common Sense Mechanics in Everyday Orthodontics* (CSM Publishing, 1040 E. Osborn Road, Phoenix, AZ 85014).

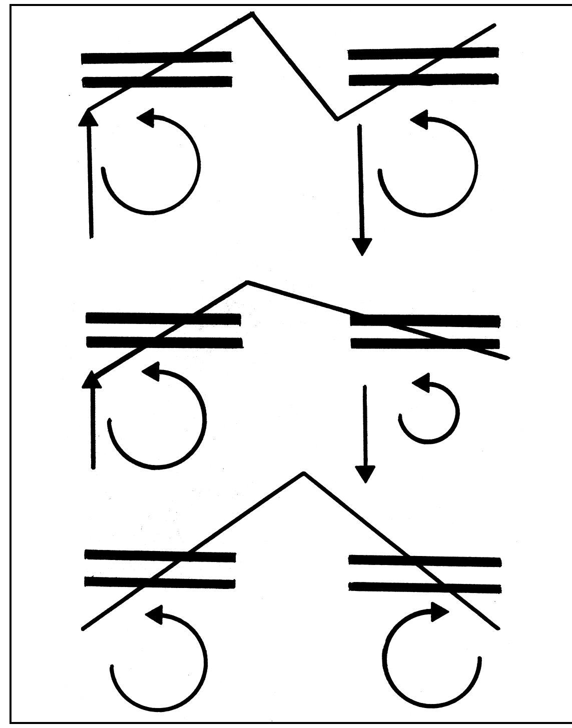


Fig. 1-1 Wire bends with aligned brackets.

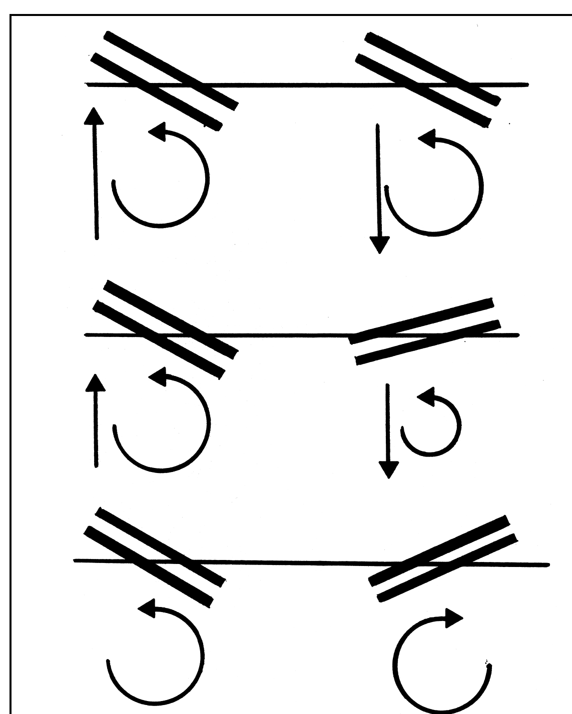


Fig. 1-2 Straight wire with angulated brackets.

in Figure 1-1, resulting in the same force systems. The latter is very useful to those who are well acquainted with these force systems, as certain actions may be applied during the alignment and leveling stages of treatment to maximize the benefits of these force systems. However, most orthodontists do not find it particularly easy to identify such force systems in the early stages of treatment. For this reason, an approach will be presented that does not require a deep knowledge of these force systems.

To a certain degree, all of these wire-bracket relationships represent some form of off-center bend. Therefore, a simple rule regarding off-center bends will prove to be helpful. If the short section of the wire is placed into the bracket first, the long section will point in the direction of the force produced at the opposite bracket (Fig. 1-3). If the long section is placed into the bracket first, the short section will point opposite to the direction of force produced at that bracket. This only makes sense, since the forces must be equal and opposite in keeping with Newton's Third Law and the laws of equilibrium. The bracket located closest to the bend will contain the larger moment, while the bracket located farthest from the bend might contain a clockwise moment, a counterclockwise moment, or no moment at all. It simply depends on the precise location of the bend. Nevertheless, this will be meaningless for molar control, as only the larger moment will be significant.

With the bend placed in the center, there are no long or short sections to the wire and therefore no forces (Fig. 1-4). Since each bracket is located at an equal distance from the bend, there will be no larger moment at one bracket, as was the case in Figure 1-3. The moments will be equal and opposite.

It should be appreciated that these rules apply regardless of the slot size chosen by the clinician or the interbracket distances involved. Do not alter your appliance of choice. Simply use what you prefer, with a better understanding of what takes place.

As mentioned above, every bend in orthodontic mechanics can be considered some variation of the off-center bend, if not a direct off-center bend. The step bend is a combination of two off-center bends, with the short sections bent in opposite directions and parallel to each other (Fig. 1-5), while the center bend is the equivalent of two off-center bends, with the short sections bent in the same direction (Fig. 1-6). The imme-

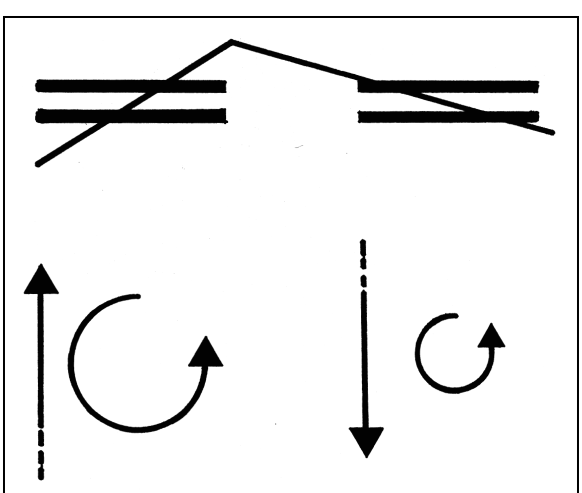


Fig. 1-3 Longer section points in direction of force.

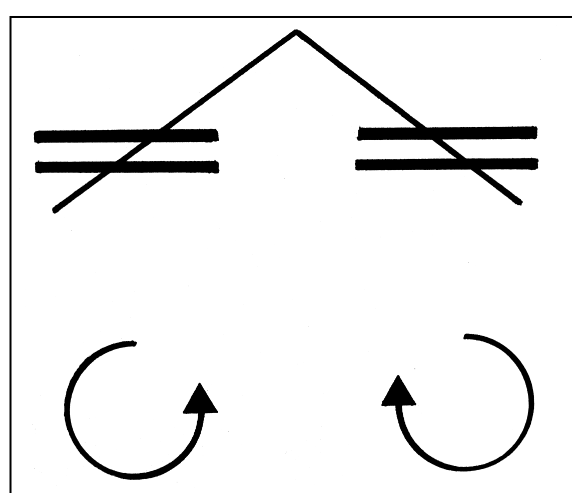


Fig. 1-4 Sections equal in length indicate no forces.

diate advantage of thinking in terms of off-center bends is that the rules presented make it relatively easy to identify the forces and moments present.

It will be seen that the bends that are used in molar control will allow the clinician to maintain molar position and to restore correct position if it is lost. These same bends will allow crossbite

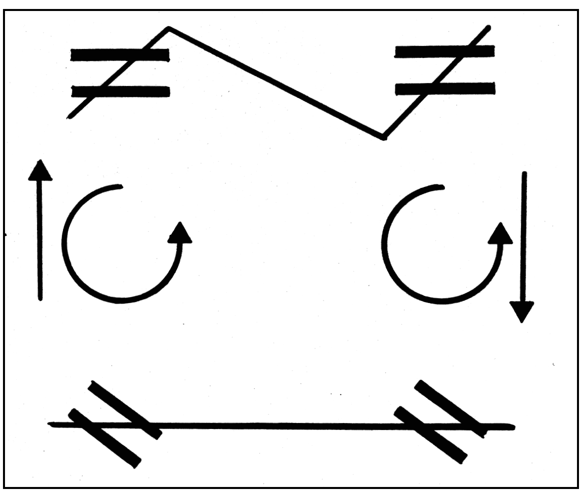


Fig. 1-5 Step bend is combination of two off-center bends with short sections bent in opposite directions.

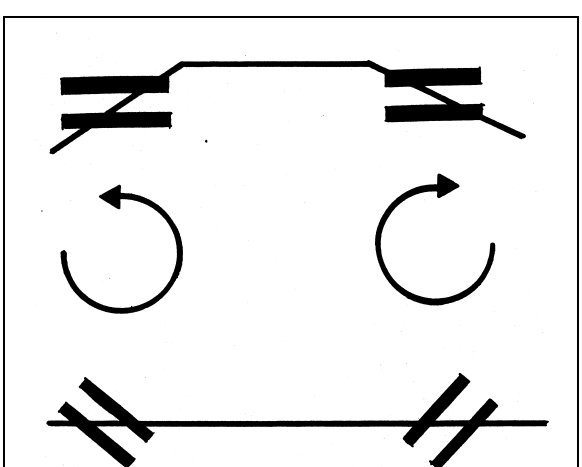


Fig. 1-6 Center bend can be treated as two off-center bends with short sections bent in same direction.

corrections without the use of interarch elastics and will therefore require no patient cooperation.

When confidence is developed that first molar position can be maintained with or without the presence of the second molars, there will be a greater willingness to remove archwires as a mandatory part of orthodontic treatment. Transverse dimensions can then be evaluated in their functional environment, as opposed to being determined by rigid appliances such as transpalatal arches, which may overcome the equilibrium of any functional environment. This concept will be explained later in the series.

Objectives in Molar Control

In Figure 1-7, the maxillary and mandibular

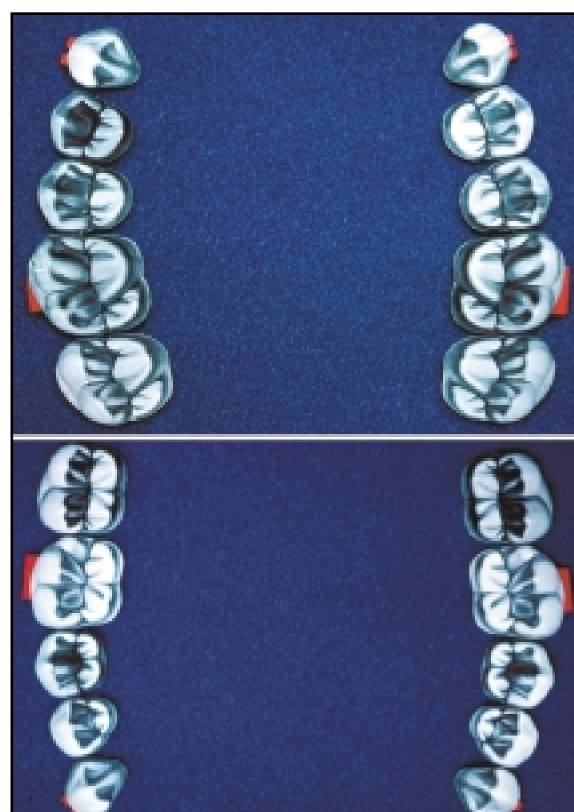


Fig. 1-7 Ideal arches with tubes present on first molars.

teeth are arranged in an acceptable archform. Tubes are present on the first molars only. It would be nice to accomplish our orthodontic objectives during treatment without altering what is already an acceptable archform. Unfortunately, many individuals discover that when the second molars are not banded, there is a lack of molar control. As a result, there are individuals who choose to band second molars for the rest of their lives just to accomplish such control. This presents a set of problems for those wishing to begin treatment before the second molars have made their appearance.

First of all, I want to make clear that the objective is not to avoid banding second molars when existing problems dictate the necessity to do so. After all, if the second molars are severely rotated or tipped, or are causing interferences, they obviously require inclusion in the strap-up. But from my conversations with many individuals, the most common reason given for the routine banding of second molars when no second molar problems exist is to provide control. Of course, it goes without saying that well-positioned second molars will require banding if they are to be moved to a new position, as might occur in some extraction cases.

When the strap-up is terminated at the first molars, the central-groove relationships between the first and second molars are frequently lost. As a result of this negative experience, it has become common for some clinicians to utilize lingual arches for control. Others tend to wait for second molar eruption before finishing their cases, so they can be assured that the first and second molar relationships are satisfactory. It is often said that the second molars don't seem to erupt into satisfactory positions with any consistency and therefore must be banded before properly finishing a case. Understand that if the second molars truly erupt in an unsatisfactory manner, there is no argument as to the need for including them in the appliance.

As this discussion proceeds, it will become apparent that most of the discrepancies occur in the first molar area during treatment mechanics. Prior to second molar eruption, there are no central grooves to be compared with those of the first molars. When first molars begin to become displaced buccally or lingually, the orthodontist frequently misses the clues that are present and then decides later, when the second molars make their appearance, that they have erupted too far to the buccal or lingual as evidenced by the central-groove disparities. If the second molars are already present but not banded, such disparities between central grooves become apparent almost immediately. As a result, these cases are then begun with the second molars banded to maintain the existing alignment of the central grooves. Of course, if it is first recognized why the lateral displacements occur, then one would quickly realize that including the second molars simply allows the first and second molars to displace themselves buccally or lingually at the same time, while continuing to maintain central-groove alignment. In addition to the buccal-lingual displacements, rotations also may take place.

This series will present a method for controlling first molar position. The assumption can be made that in the majority of cases, second molars will make their appearance with no factors inhibiting their normal eruption. Any teeth, after eruption, may be subject to negative influences that alter their correct positions in the oral cavity. In the absence of such negative influences, the next assumption to be made is that in the majority of cases, the first molars are permitted to become somewhat displaced during treatment when the central grooves are not aligned. If the clinician is unaware of this displacement, it is easy to think that the second molars are displaced when they erupt.

In any event, solutions to a problem should follow recognition of the causes. There can be no effects without causes. We live in a cause-effect world. There are, however, causes that are frequently not identified or understood.

Causes of Molar Displacement

Vertical forces acting through molar tubes during orthodontic treatment result in moments that may cause the molars to tip buccally or lingually. Extrusive forces create the potential for lingual crown tipping (Fig. 1-8), whereas intrusive forces result in the potential for buccal crown tipping (Fig. 1-9). The word *potential* is emphasized because the forces of occlusion may or may not permit the effect to take place. But the forces and resulting moments are present and must be recognized.

Since most of the cases to be shown here were initiated with partial strap-ups and concluded with full strap-ups when indicated, the discussion of molar control will assume the use of partial strap-ups unless stated otherwise. Just as lingual root torque produces posterior intrusive forces as part of the balancing system in static equilibrium, distal root torque of cuspids does the same. Any type of tooth movement that produces intrusive balancing forces in the posterior area has the potential for molar crown displacement to the buccal. On the other hand, incisor intrusion produced in a partial strap-up creates posterior extrusive forces, as labial root torque does on lower incisors. In both cases, the posterior extrusive forces are part of the balancing system for equilibrium. Any type of tooth movement that creates these extrusive forces in the posterior area results in the potential for lingual crown displacement. In summary, vertical forces acting through the molar tubes have the potential for causing buccal or lingual molar crown displacement.

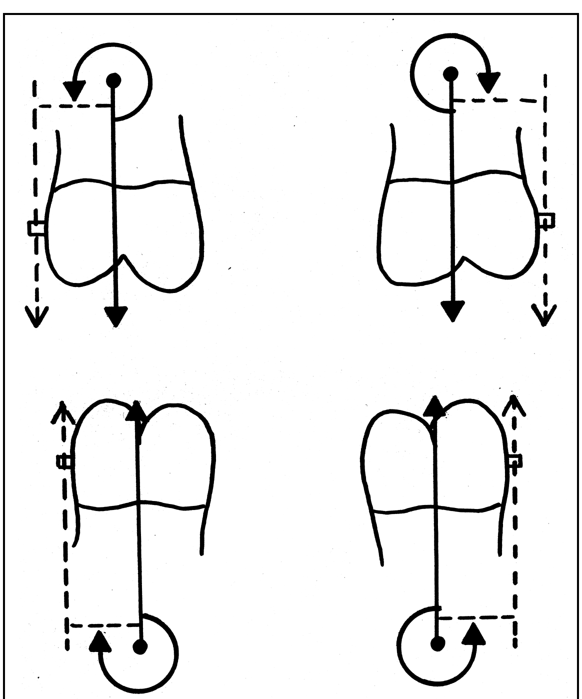


Fig. 1-8 Extrusive forces may result in lingual crown tipping.

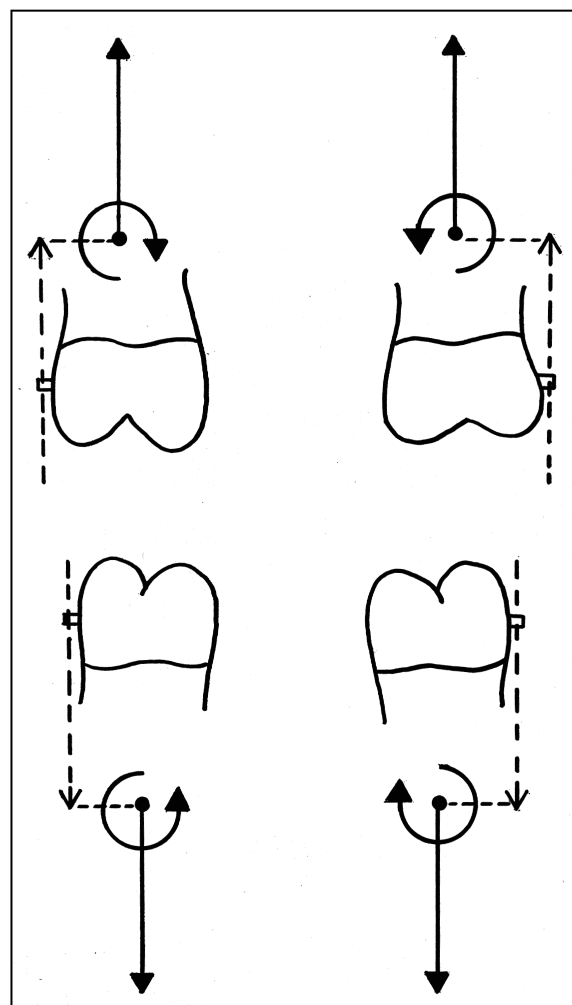


Fig. 1-9 Intrusive forces may result in buccal crown tipping.

Recognizing Molar Displacement

If the second molars are present and unbanded, first molar displacement is rather obvious. If the first and second molars are banded, displacement may occur laterally, but the

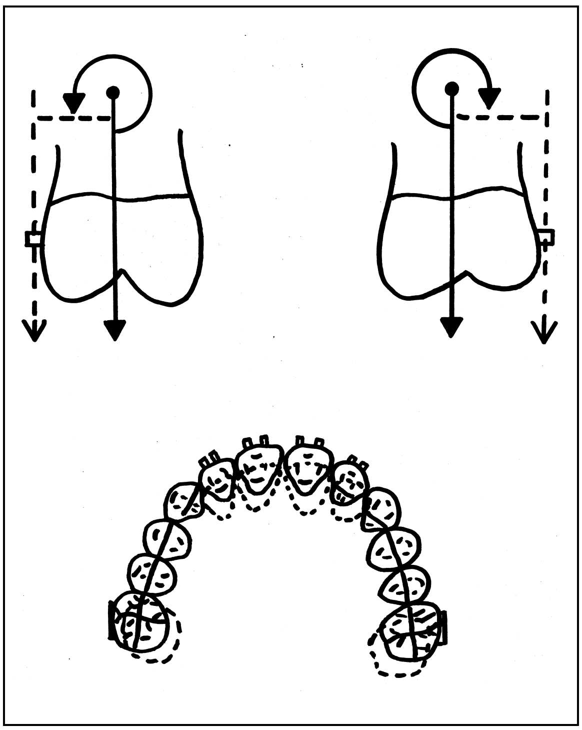


Fig. 1-10 Extrusive forces may reduce posterior arch width.

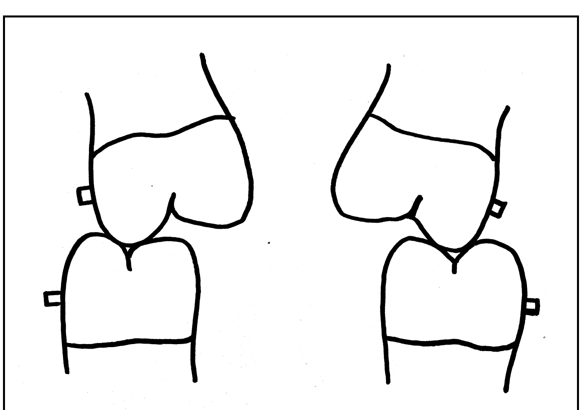


Fig. 1-11 Reduction in curve of Monson resulting from extrusive forces.

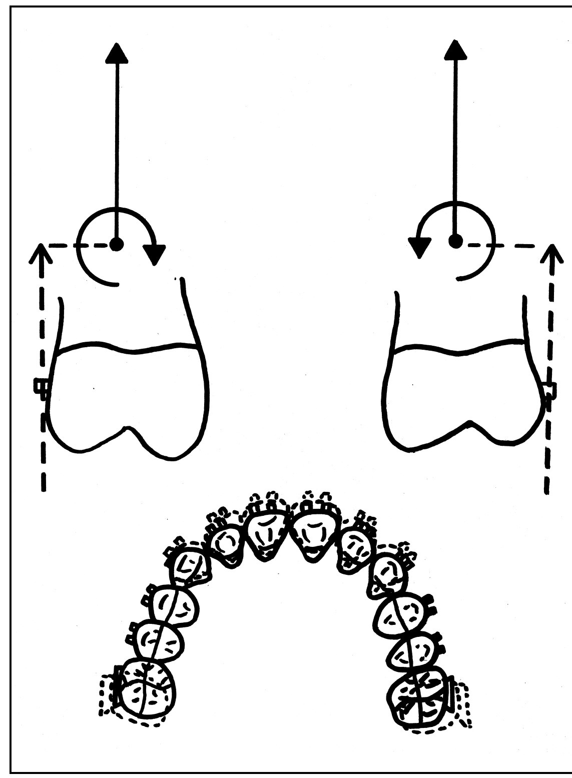


Fig. 1-12 Intrusive forces may increase posterior arch width.

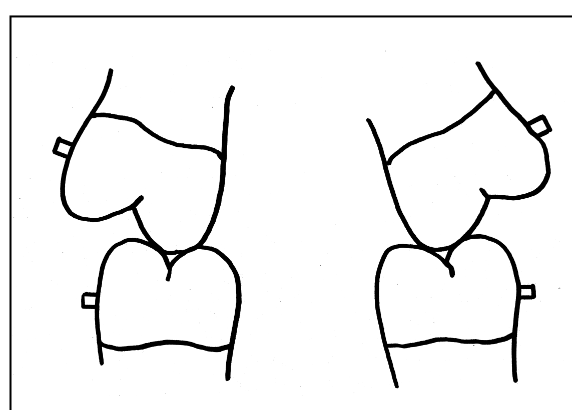


Fig. 1-13 Increase in curve of Monson resulting from intrusive forces.

central grooves will remain aligned with each other. If the first molars are banded, but the second molars have not yet erupted, lateral displacement of the first molars may go unrecognized.

The functional curves of occlusion include the curves of Monson and Wilson.

Extrusive forces acting through the molar tubes produce lingual crown moments (Fig. 1-10). If the forces of occlusion are such that crowns are able to respond, the molars will tip somewhat to the lingual. This will result in a narrowing of the posterior arch width. From a frontal view, a reduction in the normal curve of Monson will take place (Fig. 1-11). This is the first clue as to what is taking place without the need to use adjacent molars for reference. The problem will be resolved with the introduction of horizontal forces through the same molar tubes.

An intrusive force acting through the molar tube produces a buccal crown moment (Fig. 1-12). Again, if the forces of occlusion permit a response, the molars will tip to the buccal. As a result, the posterior arch width will show an increase, while from a frontal view, the curve of Monson will show an increase (Fig. 1-13). Note that any increase in the curve of Monson is a warning sign for balancing interferences. This problem, too, will be resolved when horizontal forces are applied to produce the corrective moments.

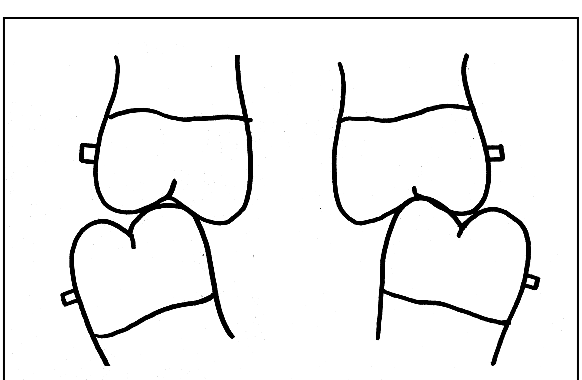


Fig. 1-14 Reverse curve of Wilson resulting from posterior intrusive forces.

The vertical forces that were shown to produce maxillary molar displacements are capable of doing the same in the lower arch. Intrusive forces through the molar tubes may result in mandibular molar displacement to the buccal, with a decrease in the normal curve of Wilson, or even a reverse curve of Wilson (Fig. 1-14). Horizontal forces create moments as seen in Figure 1-15.

An extrusive force may do the exact opposite, resulting in an increase in the curve of Wilson. In both cases, there will also be a corresponding change in posterior arch width, as was seen to occur with altered curves of Monson.

Differential Diagnosis

The changes that may take place in the

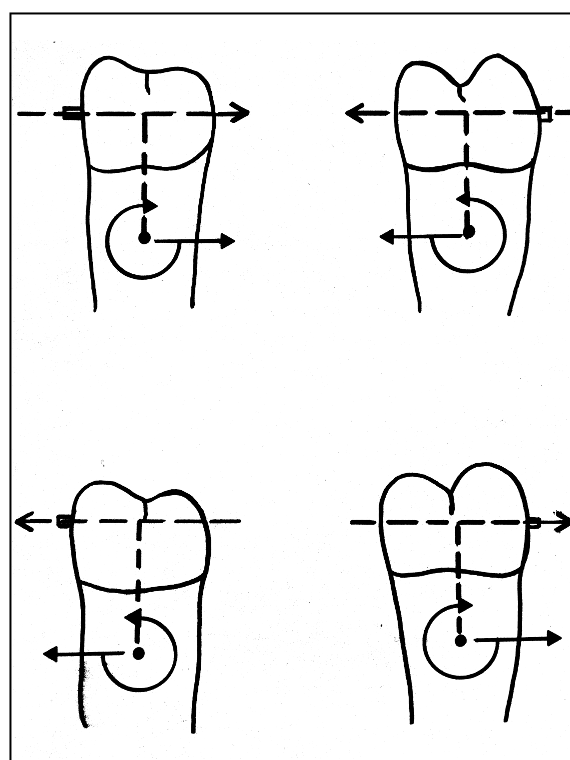


Fig. 1-15 Moments produced by horizontal forces.

functional curves of occlusion afford an opportunity to determine which arch is involved in the molar displacement. If buccal overjet is present in the molar area, it must be determined whether the upper molars have been displaced to the buccal, the lower molars to the lingual, or a combination of the two. From a frontal view, any change in the curves of Monson or Wilson will offer the answer. It doesn't make a lot of sense to use interarch elastics to resolve intra-arch problems when a problem can be clearly seen to exist in only a single arch. Later, the application of horizontal forces to resolve the problem will be presented. Not only will intra-arch mechanics be utilized, but there will be no need to depend on patient cooperation. Throughout this series, every possible means of avoiding the need for patient cooperation will be explored.

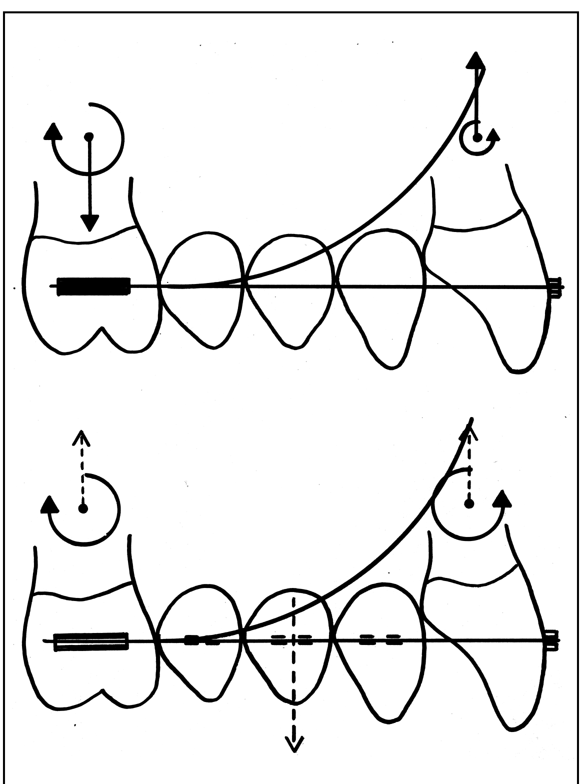


Fig. 1-16 Archwires with curve of Spee produce different vertical forces at molar in partial and full appliances.

Sources of Vertical Forces

Several sources of the vertical forces acting through the molar tubes have already been mentioned. Special mention will be made of those occurring during overbite correction, because they do not all act in the same direction.

In Figure 1-16, a partial strap-up and a full

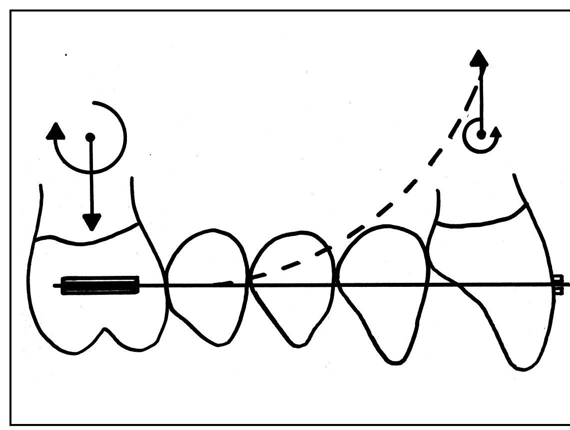


Fig. 1-17 Smaller anterior moment indicates wire is round and not rectangular.

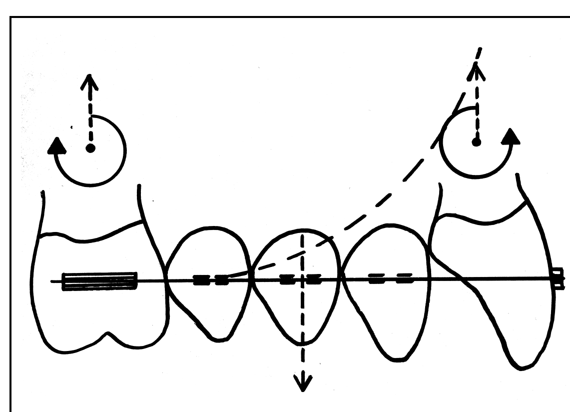


Fig. 1-18 Force system indicates wire could be round or rectangular.

strap-up are illustrated, each with a curve of Spee present in the archwire. It will be noted that the upper force system contains vertical forces acting in opposite directions at each end of the archwire. In Figure 1-17, we can see that this must be a round wire. If the wire were rectangular and filling the molar tubes and incisor slots, the equal and opposite wire-bracket angles at each end would result in equal and opposite moments with no net forces. But a round wire is incapable of forming an equal and opposite moment at the bracket. Instead, the intrusive force, acting labial to the center of resistance in the incisor segment, produces a relatively small counterclockwise moment. The posterior extrusive force means that a lingual crown moment is present on each molar, with the potential for displacement as previously discussed. Looking at the patient from a frontal view will provide the clue to displacement, as the curve of Monson will show signs of flattening. The force system pictured here is acting on the teeth, since the small anterior moment is not one produced at the bracket.

Next, Figure 1-18 shows a force system present in a full strap-up in which the wire could be either round or rectangular. The vertical forces are indicated as dashed lines, because they are not immediately present. This, by the way, is why a curve of Spee in a full strap-up is an ineffective means of correcting overbite. If it is left in place over a sufficient period of time, vertical forces will slowly develop. In the meantime, significant flaring of incisors will have taken place. When vertical forces ultimately occur, they will be intrusive at the molars. This means that a buccal crown moment will be created at each molar, with the potential for buccal crown displacement. Again, if lateral displacement does occur, looking at the patient from the frontal view will reveal a steepening of the curve of Monson.

When the clinician becomes totally familiar with a functional curve of occlusion, it is easy to recognize and describe any change. Think of how often we refer to a deep curve of Spee or a

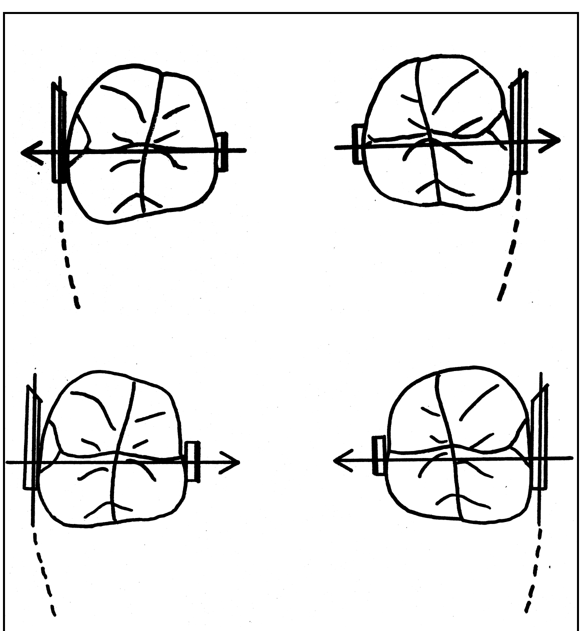


Fig. 1-19 Horizontal forces acting through molar tubes.

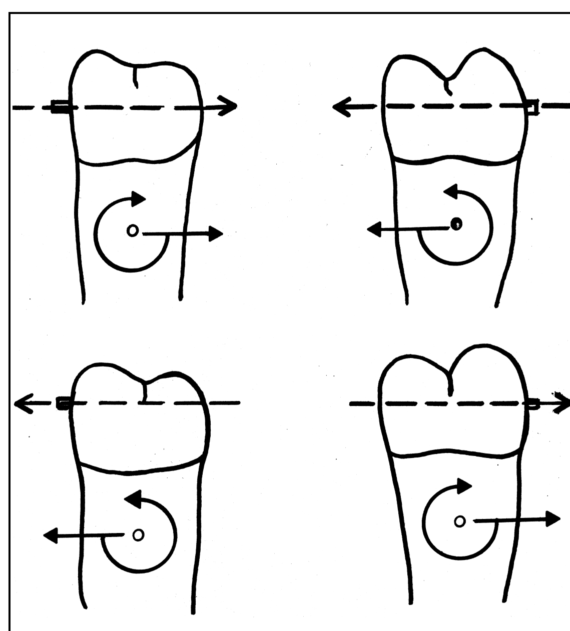


Fig. 1-20 Horizontal forces produce lingual and buccal crown moments.

flattening of the curve of Spee. Not only do we know what we are describing, but others listening to our description can clearly picture in their minds what we are describing. Once the curves of Monson and Wilson become part of our vocabulary, the changes that take place will have additional meaning. It will make us more aware of the total force systems that act on teeth, and it will also help us realize that unintended forces are just as effective in producing undesirable tooth movement as intended forces are in creating desirable responses.

Creating Horizontal Forces

The buccal and lingual forces seen acting through the molar tubes in Figure 1-19 are not the forces that normally occur with the various types of tooth movement previously discussed. The forces shown are those that will purposely be introduced by the orthodontist to produce the moments necessary for molar control. A lingual force through the molar tube results in a lingual crown moment, whereas a buccal force applied through the same tube will produce a buccal crown moment (Fig. 1-20). As stated before, crown tipping will then be dictated by the forces of occlusion. This means that crown tipping will occur in some patients, while in others it will not. It is important to understand that the moments are present, regardless of the response.

Figure 1-21 shows the clinical significance of the difference between horizontal and vertical forces. Horizontal forces generally produce greater moments than will vertical forces acting through the same molar tubes. This is because the perpendicular distance between a horizontal force and the center of resistance in the molar is greater than the perpendicular distance between a vertical force and the same center of resistance.

As explained earlier, all wire activations are made intraorally, applying 45° bends in each instance with a Tweed-loop plier. The angles are constant in both vertical and horizontal planes of space, and the interbracket distances are identical for the bends involved. The cross-sectional configuration of the archwire is also the same for both bends. Therefore, the magnitude of the vertical forces will equal the magnitude of the horizontal forces. No measurements are necessary. The only reason for one moment being greater than the other is the different perpendicular dis-

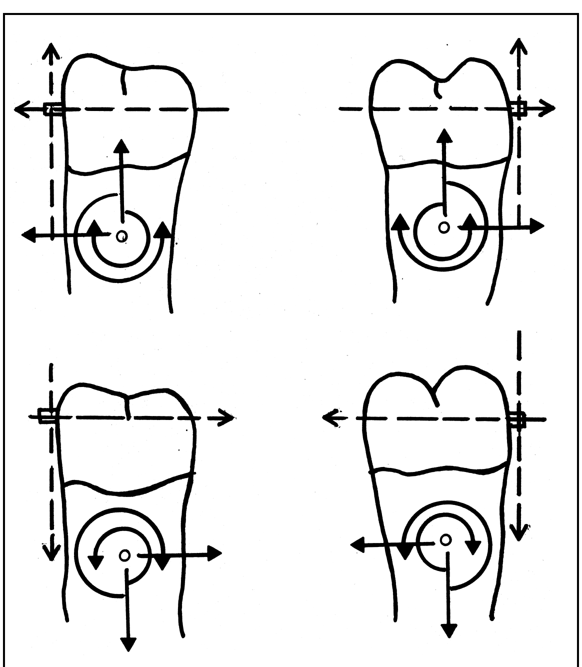


Fig. 1-21 Horizontal forces produce greater moments than do vertical forces.

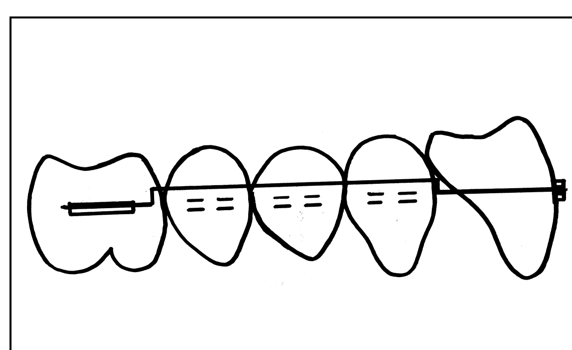


Fig. 1-22 Bypassing teeth with continuous archwire.

tances between these forces and the center of resistance.

Rigidity vs. Resilience

Laws of equilibrium cannot be violated in any plane of space. Therefore, when a horizontal force is introduced to provide the appropriate moment, there must be an equal and opposite force in the same plane of space. These equal and opposite forces will express themselves on the teeth adjacent to the bend. For example, if a partial appliance consists of six bonded anterior teeth and two banded molars, a continuous arch producing horizontal forces through the molar tubes will also produce equal and opposite forces through the cuspid brackets. If sectional arches were in place instead of a continuous arch, it wouldn't take long to see the undesirable effects on the cuspids.

Much has been written in the literature about the differences between sectional and continuous arches. I prefer to use continuous arches, because there will be fewer balancing forces involved. This is because a continuous arch has only two free ends, but sectional arches have six free ends when two buccal segments and an anterior segment are used.

Figure 1-22 demonstrates how sectional tooth movement can still take place with the use of a continuous arch. Other teeth may simply be bypassed. As a result, the vertical forces that are exerted through the molar tubes may be properly dealt with by the molar-control bends that will be discussed later. Equal and opposite forces cannot be avoided, but there is a clever way to prevent an equal and opposite response in the occlusal plane of space. When the horizontal forces are applied at the molar tubes, the partial strap-up may consist of brackets either on the incisors only or on all six anterior teeth. This creates an area of relative rigidity, while the molars lie in an area of resilience—illustrating the concept of applying anterior rigidity to posterior resilience. Horizontal forces are capable of producing significant posterior movement while the equal and opposite forces produce a negligible response at the adjacent teeth, which lie in the anterior area.

This concept is illustrated in Figure 1-23, where four incisors have been bracketed (2 × 4). There are many ways of further enhancing rigidity. An anterior segment can be inserted into the incisor slots with a continuous arch overlay (Fig. 1-24). Another effective means of increasing rigidity, using the wire shown in Figure 1-23, is to overlay an anterior segment. The latter is the more desirable overlay approach, for reasons that will become apparent later. Nevertheless, I prefer to use only a continuous arch, with no other

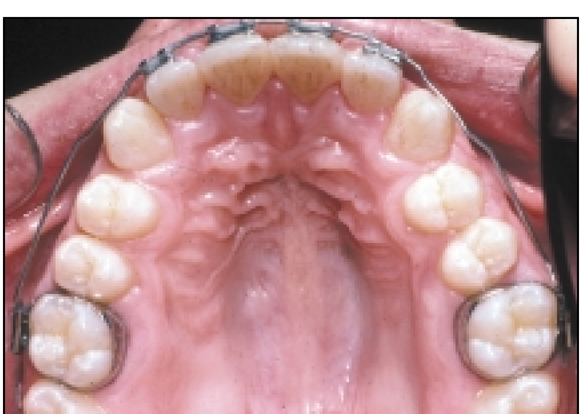


Fig. 1-23 Anterior rigidity vs. posterior resilience in partial strap-up.

Fig. 1-24 Anterior segment with continuous arch overlay to enhance anterior rigidity.

wires added. The side effects are so negligible as to keep treatment simple. When the molar-control bends are removed, complete recovery from any side effects usually takes place within one appointment.

Force Systems in Molar Control

This series will present a very simple procedure for deciding exactly where to place the bends utilized in molar control. Figures 1-25 and 1-26 show three wire-bracket relationships that have already been discussed, using either standard slots with the bends placed in the wire (Fig. 1-25) or prescription (malaligned) brackets with straight wires (Fig. 1-26). It can be seen that the force systems are the same in each figure because the wire-bracket angles are the same for each of the three relationships.

Although these force systems will be discussed later in more detail, it is interesting to note that the force systems produced by each

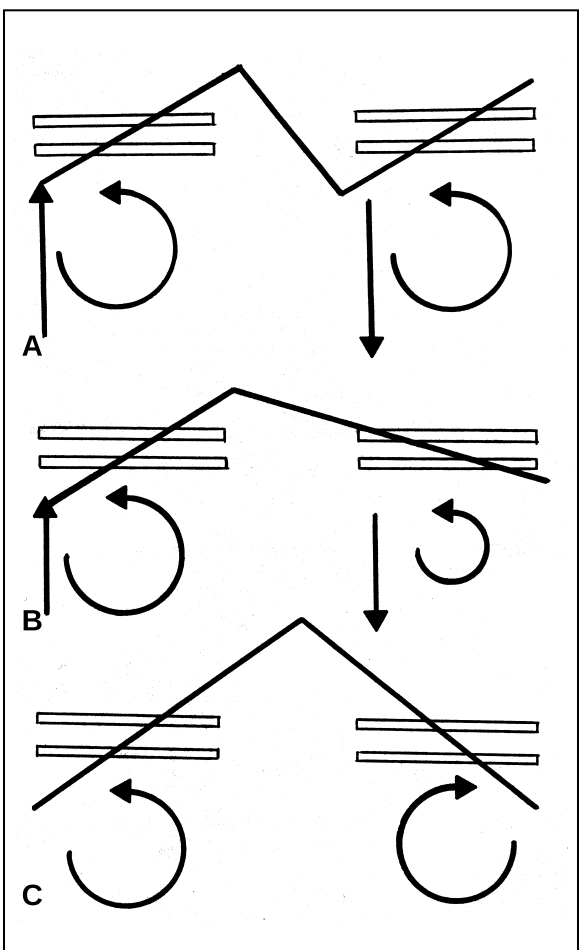


Fig. 1-25 Force systems using standard slots with bends in wire for step (A), off-center (B), and center bends (C).

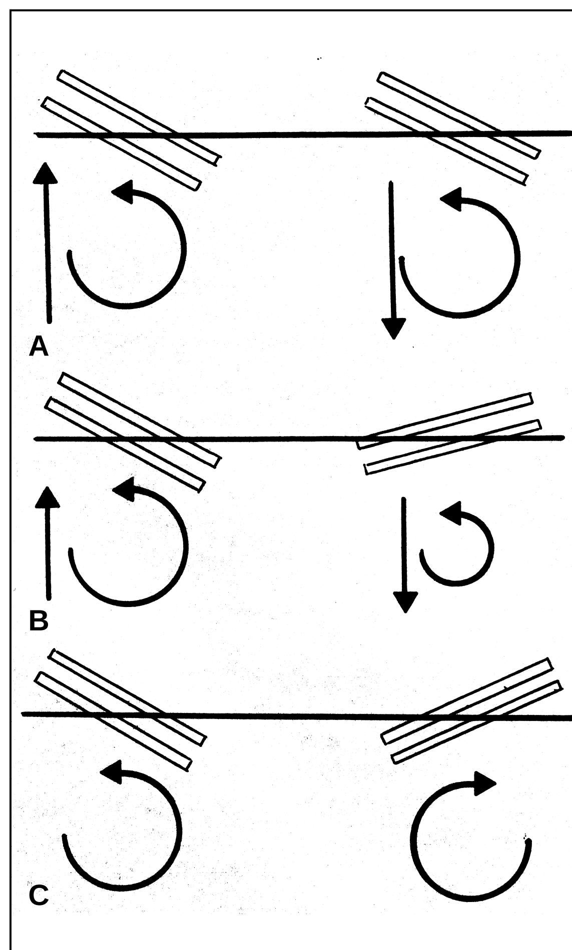


Fig. 1-26 Force systems using prescription slots with straight wires for step (A), off-center (B), and center bends (C).

wire-bracket relationship may also be provided, when needed, by the molar-control bends. It is not necessary at this point to know anything about these specific wire-bracket relationships, as all three have been treated as off-center bends. Remember, the step was treated as two off-center bends with the short sections pointing in opposite directions, while the center bend was treated as two off-center bends with each short section pointing in the same direction. Under the rules given for determining the forces and moments produced by these off-center bends, it will be seen that regardless of the position of the molar, correction will be easily obtained by applying the off-center bends. The sequence to be provided will, in effect, produce the best of the force systems available to correct the problem. The orthodontist will not even have to recognize which wire-bracket relationship is associated with the force system. In time, repeating the process will firmly establish the relationship in one's mind.

To maximize the benefits of this system in the daily practice of orthodontics, it is important not to throw the baby out with the bath water. The entire approach to molar control will place emphasis on correcting the problem and not on concerning ourselves with every last detail if it is not pertinent to the problem. Be ready for some pleasant surprises. Whether the molar is rotated one way or the other will make no difference. Whether the molar is buccal or lingual will likewise make no difference. Regardless of what combination of rotations and displacements occurs, all solutions will be found to be equally effective and easily applied.

A Farewell

If you have found it necessary to use lingual arches to prevent molar displacements, or to correct such problems once they occur, it is time to bid them farewell. If you have placed second molar bands when they are not needed, except to control well-positioned molars from the start, again bid farewell. Do not misinterpret these statements to mean that lingual arches and second molar bands are contraindicated in orthodontic treatment. They certainly serve their purpose, but at the same time, they are used far more often than necessary by many excellent orthodontists.

Now that an introduction to molar control has been provided, the subject will be divided into three general categories: off-center bends, step bends, and center bends. Clinical treatments will be presented demonstrating the use of toe-in bends and toe-out bends. This will be followed by illustrations of in-bends and out-bends. Finally, the step and center bends will be demonstrated clinically. The treatments shown in each area should confirm the ease of applying the various bends and obtaining the desired results.

SUGGESTED READING

1. Mulligan, T.F.: Common Sense Mechanics office course, Phoenix, AZ.
2. Dawson, P.E.: *Evaluation, Diagnosis, and Treatment of Occlusal Problems*, Mosby, St. Louis, 1989, pp. 85-91.