Common Sense Mechanics

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1

The title "Common Sense Mechanics" is based on the simple fact that no appliance exists which will allow an orthodontist to treat orthodontic problems without adding the necessary ingredient of "Common Sense" to the mechanics instituted for correcting the malocclusion. Appliances are being refined and will continue to improve with the passage of time. This is good, but the danger lies with the individual who fails to recognize that the refinement of appliances may reduce the physical effort put forth in treatment, but will not eliminate the need for the orthodontist to think, understand, and apply basic principles of mechanics in a common sense manner. This means that regardless of how well we understand mechanics and regardless of how much the appliance is refined, we are dealing with a biologic environment whose variation in response will continue to challenge the orthodontist in many ways. If we are to meet this challenge, we must gather as much information as possible that will allow us to treat the patient in a practical or realistic manner, rather than treating in a textbook fashion. The textbook, for example, may help us to determine how equal and opposite forces are produced, but such forces do not necessarily produce equal and opposite responses (Fig. 1).

Since it is the response we seek, we separate ourselves from those professionals who deal with pure physics and enter the exciting and challenging arena of biophysics where we take many principles into account, mix them with common sense, and proceed to

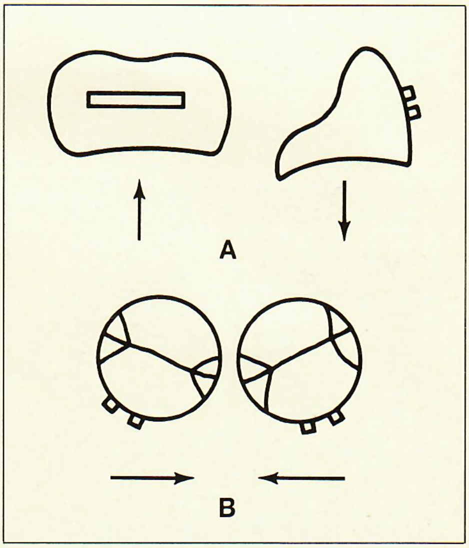

Fig. 1 A. Vertical Plane of Space. Equal and opposite forces usually produce unequal response. B. Horizontal Plane of Space. Equal and opposite forces tend to produce equal and opposite response.

treat the problem in a more predictable and efficient manner with a higher level of confidence. Instead of learning through trial and error, and instead of repetitive error year after year with the same problems, we can avail ourselves of the opportunity to predict such errors before they ever occur, so that our common sense approach to the application of mechanical principles will not only help us to solve the problems at hand, but will permit us to avoid those problems we so often introduce into the treatment procedures.

Common Sense is such an important part of applying basic mechanics that without it, even the most sophisticated knowledge of the subject offers one little in attaining his treatment goals. Perhaps it is a lack of a combination of the two—knowledge of mechanics and common sense application—that has led to the desire on the part of many orthodontists to seek an appliance which does the thinking. If such is the case, there will be many frustrations which will persist. In no way is this statement intended to be critical of any appliance. It only points out the fact that orthodontists cannot escape the need to understand the appliance of choice and the various force systems which will enter the treatment picture, either as our "friends" or as our "enemies".

Visual Inspection

Before proceeding into a discussion of useful mechanics, experience has proven to the author that it is first necessary to dispel one of the methods so frequently used by a majority of orthodontists in determining what forces are present once an archwire is fully engaged into a bracket or tube. During various seminars, it has been quite apparent that this method,

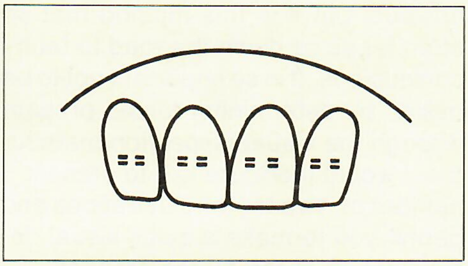

Fig. 2 Wire inserted into molar tubes prior to insertion into incisor brackets.

which I will refer to as the "visual inspection method", is what often confuses the orthodontist in attempting to determine with reliability what forces are present.

If, for example (Fig.2), the orthodontist inserts an archwire into the molar tubes and observes that prior to placement of the archwire into the incisor brackets, the wire lies in the mucolabial fold, it is often concluded that this means there must be produced an anterior intrusive force upon engagement. This may very well be true, but likewise, it may be very untrue. There not only may be no force present, but there might even be present an anterior extrusive component of force. Have you found yourselves at times watching overbites increase at the very time overbite correction is being attempted? Have you waited for month after month for certain overbites to "go away" because of the "known" intrusive force present for correction, only to see the overbite persist? Have you ever surprisingly observed the return of overbite for no apparent reasons after having spent months on correction? Well, sadly enough, the answer often lies in the fact that the force thought to be present is never there, and sometimes the exact opposite force is present.

The visual method seems to be so

obvious, but it is this method that so often leads us down the road to faulty conclusions. It is so important not to be misled by determining forces present through the visual inspection method, that I would therefore like to present a number of "two teeth" illustrations and permit you to make a quick visual determination of the forces present.

Clinically, such determination is usually made instantly, so don't spend time trying to figure out the answer. Since you will be observing only two teeth, and since you will only be attempting to determine forces, not moments, you should find yourself dealing with a much greater degree of simplicity and accuracy than you actually do with your everyday patients. If you find, in the end, you have erred on occasion, then you can assume your degree of error is much higher on multibanded teeth or full strapups. It would indicate that the visual inspection method is not a reliable method and often accounts for many problems. So, let us proceed to determine what forces, if any, are present on the particular tooth in question. Disregard the moments altogether and ask only whether there will be an intrusive or extrusive force present—or no force at all.

The correct answers to the illustrations are provided at the bottom of each page. Cover these answers and circle your choice of force determination under each illustration. Then check your choices with mine.

In Figure 3, the archwire is inserted into the cuspid bracket. Although we would normally insert the wire into the molar tube first, it makes no difference, since we are concerned only with the total force system that exists when the archwire is fully engaged in all brackets and tubes. Visually, what force, if any, do you predict

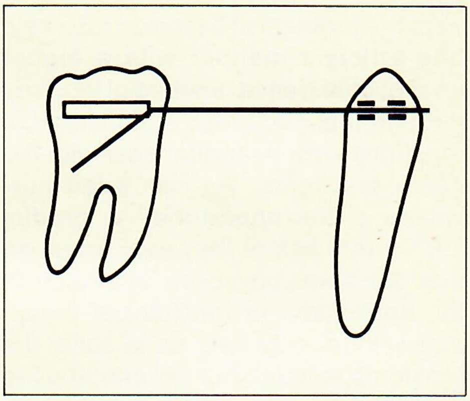

Fig. 3 What force will be produced?
A. On the molar? *(Extrusive Intrusive None).**
B. On the cuspid? *(Extrusive Intrusive None).**

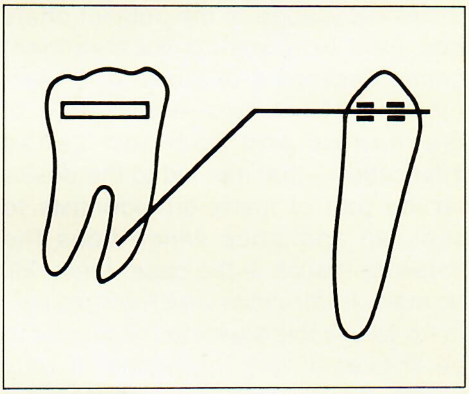

Fig. 4 What force will be produced?
A. On the molar? *(Extrusive Intrusive None).**
B. On the cuspid? *(Extrusive Intrusive None).**

would be present on the molar? What force would occur on the cuspid? Disregard any moments. Keep your observation simple.

In Figure 4, the archwire is again inserted into the cuspid bracket. Upon insertion into the molar tube, what force would exist on the molar? What force would exist on the cuspid? Are you certain that such forces even

*Correct answers: Fig. 3 - A. *Extrusive*, B. *Intrusive*. Fig. 4 - A. *None*, B. *None*.

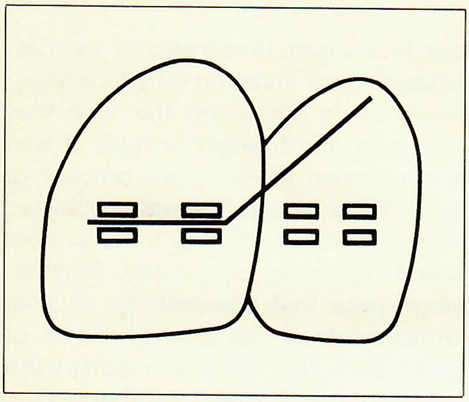

Fig. 5 What force will be produced?
A. On the lateral incisor? ***(Extrusive Intrusive None).****
B. On the central incisor? ***(Extrusive Intrusive None).****

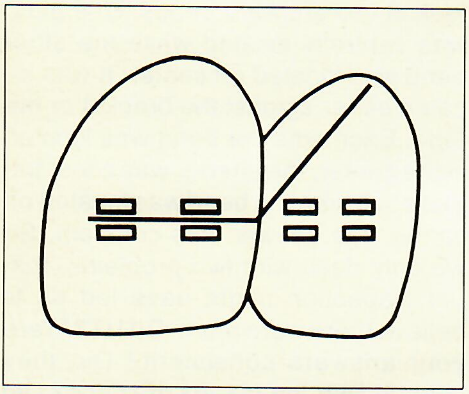

Fig. 6 What force will be produced?
A. On the lateral incisor? ***(Extrusive Intrusive None).****
B. On the central incisor? ***(Extrusive Intrusive None).****

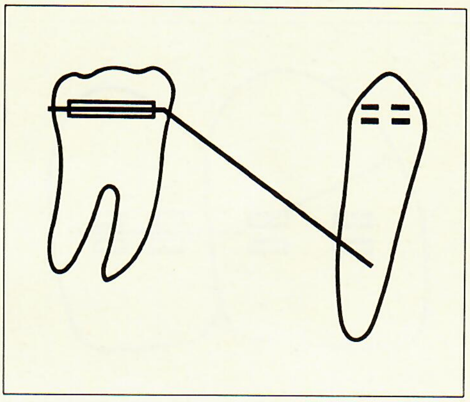

Fig. 7 What force will be produced?
A. On the cuspid? ***(Extrusive Intrusive None).****
B. On the molar? ***(Extrusive Intrusive None).****

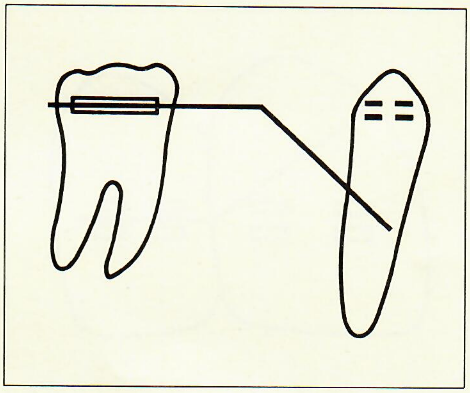

Fig. 8 What force will be produced?
A. On the cuspid? ***(Extrusive Intrusive None).****
B. On the molar? ***(Extrusive Intrusive None).****

exist?

In Figure 5, what force will be produced on the lateral incisor upon archwire insertion? What force would exist on the central incisor?

In Figure 6, the question remains the same. What force do you feel would become present on the lateral incisor and what force would you expect to find on the central incisor?

At this point, the questions must appear to be very boring and the answers quite obvious, but please exercise patience and continue with the questions.

In Figure 7, what force would become present on the cuspid when the archwire is inserted into the cuspid bracket? How about the molar?

In Figure 8, what force will be produced on the cuspid? What force might become present on the molar?

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*Correct answers: Fig. 5 - A. *Intrusive*, B. *Extrusive*. Fig. 6 - A. *None*, B. *None*. Fig. 7 - A. *Intrusive*, B. *Extrusive*. Fig. 8 - A. *None*, B. *None*.

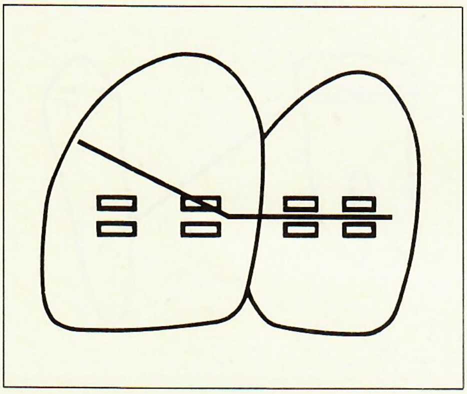

Fig. 9 What force will be produced?
A. On the central incisor? *(Extrusive Intrusive None).**
B. On the lateral incisor? *(Extrusive Intrusive None).**

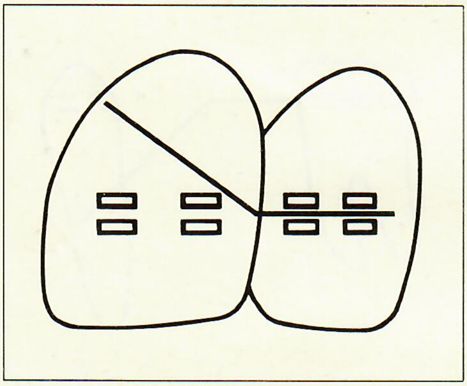

Fig. 10 What force will be produced?
A. On the central incisor? *(Extrusive Intrusive None).**
B. On the lateral incisor? *(Extrusive Intrusive None).**

In Figure 9, what force will be produced on the central incisor? What would be produced on the lateral incisor?

FINALLY, in Figure 10, what force would be produced on the central incisor and what force would be produced on the lateral incisor?

If you haven't already quit in boredom and disgust, please notice that the last eight illustrations we discussed really involved only four situations, since whenever the wire was shown in one bracket or tube, it was again shown in the other bracket or tube. Thus, a given situation utilized two illustrations, but the force system would be totally unaffected. Furthermore, note that one-half the illustrations involved the buccal plane of space while the other half involved the anterior plane of space. In other words, the same questions were simply repeated in a different plane of space, which did not change the problem.

Actually, all we have done is to look at two archwire bends. One bend was centrally located while the other bend was located off center. It was located either against the bracket or the tube. Each time the bend was located in the center, the answer was constant, and each time the bend was located off center, the answer was constant. So we only dealt with two problems. Visual inspection might have led us to believe there were more. DID IT? Were your answers consistent? Did they change with the planes of space? Did they vary according to which bracket or tube received the wire first? They shouldn't—it makes no difference.

There is only one force system that can exist for each of the two problems presented. When the bend was located exactly in the center, there were no forces present. How does this compare with your answer? Actually, the centered bend produced only equal and opposite moments, but no forces—not a bad situation when we wish to parallel roots following space closure, or rotate teeth equally and oppositely. How about the off-centered bend? Well, the off-centered bend produced equal and opposite forces, but the moments were no longer equal.

*Correct answers: Fig. 9 - A. *Extrusive*, B. *Intrusive*. Fig. 10 - A. *None*, B. *None*.

They became unequal when the bend moved away from center. I realize moments are aside from the subject of forces. Moments will be discussed in the next installment.

What does all of this mean? Well, it means that in a given plane of space, WE can determine or recognize the forces present by noting the location of the bend. Once we have attained bracket alignment, further force systems can be determined by the orthodontist instead of by the malocclusion.

A Simple Rule

Let me present an oversimplified, but practical and usable rule which can help you in your practice immediately. Later, I will present material on wire/bracket relationships in an easy to understand form, and prove to you why these forces must exist, regardless of what visual inspection might lead you to believe.

First, if the bend is located off center, there will be a long segment and a short segment. When the short segment is engaged into the bracket or tube, the long segment will point in the direction of the force produced on the tooth that will receive the long segment. If you refer back to Figure 7, you will notice that the long segment points apically to the cuspid, meaning cuspid intrusion—and therefore, molar extrusion. Another way to think of it is this: The short segment points in the opposite direction of the force that will be produced on the tooth that receives the short segment. In Figure 3, the short segment points apically to the molar, so the force on the molar is extrusive, meaning that the cuspid will receive an intrusive force. This is certainly different than visual inspection might lead us to believe.

Next, if the bend is in the center, there no longer exists a long or short segment. Therefore, no force is produced. This is difficult for some to believe, as there can be tremendous forces involved in getting the wire into the bracket or tube, but as we will see later, these forces cancel each other upon archwire engagement, leaving pure moments. Worthwhile mentioning is the fact that because we deal with forces in various planes of space which, of necessity, are equal and opposite, anytime we incorrectly determine one of these forces, we introduce additional error with its opposite.

It must be said at this point that common sense must always be present. Determining the presence and direction of a force is an important part of efficient mechanics, but by itself does not describe or predict tooth movement. Obviously, an ankylosed tooth would not respond to the force. Likewise, we must consider other factors such as forces of occlusion, cusp height, habits, etc.; but regardless of these other factors, if we can reliably know the force present and its direction, we know most likely where the teeth WILL NOT move and can concentrate on where we wish to position the teeth.

Now that the fallacy of the visual inspection method has been discussed, and simple, but useful, rules presented concerning the use of centered and off-centered bends, let us move from the buccal and anterior planes of space and proceed to ask questions similar to those before. But this time, disregard the use of visual inspection and adhere to the simple rules governing centered and off centered bends. See if it helps you solve the problem in an instantaneous and non-confusing manner.

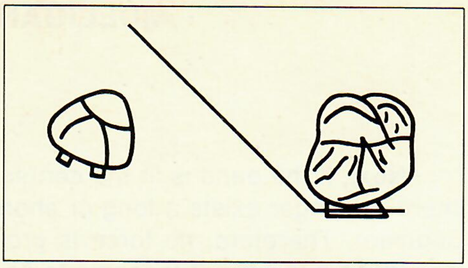

Fig. 11 What force will be produced?
A. On the cuspid? *(Buccal Lingual None).**
B. On the molar? *(Buccal Lingual None).**

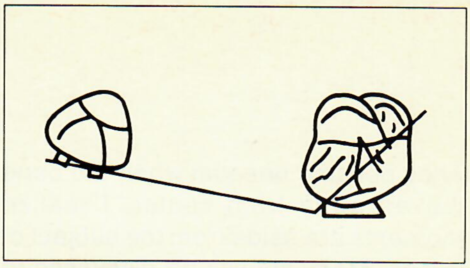

Fig. 12 What force will be produced?
A. On the molar? *(Buccal Lingual None).**
B. On the cuspid? *(Buccal Lingual None).**

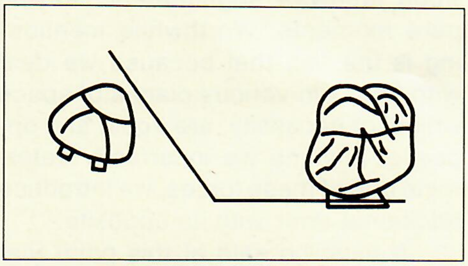

Fig. 13 What force will be produced?
A. On the cuspid? *(Buccal Lingual None).**
B. On the molar? *(Buccal Lingual None).**

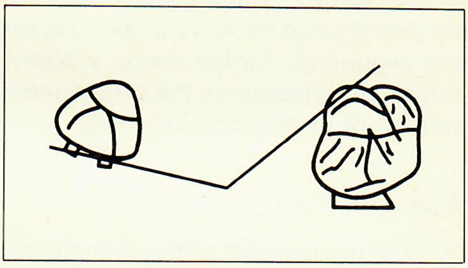

Fig. 14 What force will be produced?
A. On the molar? *(Buccal Lingual None).**
B. On the cuspid? *(Buccal Lingual None).**

In Figure 11, the wire is inserted into the molar tube. What force would exist on the cuspid upon archwire insertion, and what force would occur on the molar?

In Figures 12, 13, and 14, ask yourself the same questions. We are simply trying to determine whether the forces involved are buccal or lingual, or even present. Can you begin to see the ease and accuracy in using a method that eliminates visual inspection? Isn't it comforting to know that you can look at Figure 12 and predict a buccal force rather than a lingual force? Isn't it just as comforting to look at Figure 13 and know the cuspid will not move lingually because there is no force acting on the tooth?

Remember, that at this point we are looking at "two teeth" illustrations only. The picture becomes more complex, but we will attempt to deal with these complexities as we go along. In the material thus far presented, it has only been my intention to introduce the subject and, hopefully, to create an awareness that we cannot reliably determine force systems by "visualizing" the relationship of archwire to tube or bracket. In this material, forces have been discussed. Next, moments will be discussed, and we will then look at what really occurs when we start placing different kinds of bends into the same archwire. It will be interesting to see what effects lingual root torque and labial root torque produce on incisors. It will be interesting to begin to observe what happens at both ends of the archwire instead of just one, as is so often the case. You may even begin to sense a new excitement in YOUR mechanics as we move along.

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*Correct answers: Fig. 11 - A. *Lingual*, B. *Buccal*. Fig. 12 - A. *Buccal*, B. *Lingual*. Fig. 13 - A. *None*, B. *None*. Fig. 14 - A. *None*, B. *None*.