Mechanical Principles And Orthodontic Appliances*

WILLIAM S. PARKER, D.M.D., M.S.**

Sacramento, California

The true goal of any orthodontist should be to perform successful tooth movements and to constantly improve his ability to correct malocclusions. This is a purposely brutal simplification of the total task of the orthodontist. Of course, I know all of the fine distinctions about harmonizing facial contours and bony bases, aiding growth and development, correcting habits and muscular perversions and all the peripheral problems. And although I believe in the health benefits of orthodontics in some cases, the majority of patients are placed in our hands for one reason only, to align their teeth to improve their appearance.

Perhaps for too many years all orthodontic thought, study and teaching was focused on means and methods to move teeth but perhaps for too many recent years most orthodontic thought, study and teaching has been focused on the peripheral problems. Can you visualize one of us winning a research prize from any orthodontic group for developing a better technique to straighten teeth? For developing a better banding technique or bracket? For developing a better archwire or headgear? It is doubtful that such an entry would even be seriously considered.

Study of journals and texts reveals that there has always been a divergence of opinions as to the relative importance of the biological as opposed to the mechanical training of orthodontists. There probably always will be. My thesis is fairly simple: We can trace headfilms and measure them till infinity; conduct searching physical examinations involving blood, B.M.R., endocrine glands and what-not; perform diagnostic set-ups or employ gnathostatics or even study heredity and nutrition to help us reach a diagnosis and formulate a treatment plan but, once reached, we still have to correct the malocclusion satisfactorily.

This divergence of viewpoint was in evidence over fifty years ago when Dr. Angle and Dr. Case were the giants on the scene. At that time Dr. Angle quite properly was calling attention to the biological aspects and said,[1] "Much has been written upon the subject of orthodontia but mostly from the mechanical standpoint, and only very recently has it begun to receive that broad and thorough study which a science of such great importance demands, for its basic principles are grounded in the mysteries of embryology, histology and comparative anatomy, linked with art and physics." Case was saying,[2] "Those who hold to the theory that there are in the main, only three classes of irregularity which are characterized solely by their relations to normal occlusion, and which may be corrected with a few simple purchasable appliances, naturally take the ground that all training in the mechanical construction of regulating bands and appliances is a waste of valuable time, and of no practical advantage in practice."

*Presented before the Edward H. Angle Society of Orthodontia, Colorado Springs, October, 1959.

**Consultant, School of Dentistry, Un. of California.

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-05-14 via free access

As in all differences of opinion there was much of truth in both viewpoints. And those who knew these two men point out that Dr. Angle was truly an excellent mechanic and that Case was a fine student of biology. But now let us spend a few moments with mechanics and mechanical principles. Mechanics[3] is "that part of physical science which treats of the action of forces on bodies" and this is precisely what we do all day—apply forces to dentofacial structures to obtain certain reactions. Thus, simply pushing or pulling become mechanical acts and Newton long ago explained the results of this type of activity. But in man's dim historic past he invented certain mechanical devices through which his strength could be multiplied; the lever, the wheel, the inclined plane, the pulley, and the screw are the basic foundations upon which all his complex mechanisms rest.

Archeological studies show that man applied forces to move teeth in times long forgotten. Fauchard is generally credited with being the first to devise and use orthodontic arches around 1726. Plain bands were constructed several thousand years ago for prosthetic purposes but around 1848 Schange developed the clamp band for orthodontic use. He also was one of the first to make use of the elasticity in rubber to move teeth and to recognize the necessity for retention.

Delabarre introduced removable appliances in 1815 and Kneisel the headgear about 1836. Dwinelle developed the jackscrew in 1849. Magill is credited with being one of the first to use oxychloride of zinc cement to attach bands to the teeth about 1871.

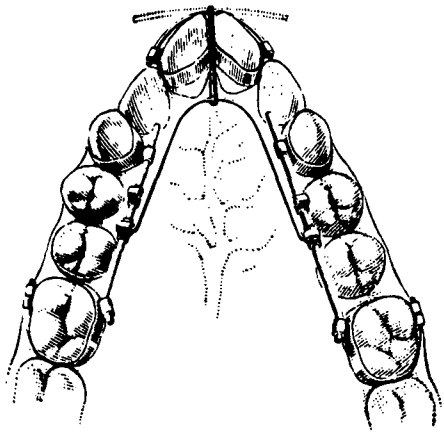
While many men contributed extremely important improvements and are still doing so, within these basic ideas are encompassed nearly all orthodontic thought and action. From the basic idea of an ideal arch flows most of the wide stream of orthodontic effort. Think of it for a moment—whether the ideal arch is ivory, wood, metal, gold, vulcanite or steel and whether the teeth are tied to it or pushed by steel, brass, gold, silk, linen or rubber, the action is the same. If all teeth are to be retained it may be known as an expansion arch, if teeth are extracted it may be called something else. Still it is the form and structure to which the teeth are guided. The concept of attachment of the appliance by means of bands or cribs and clasps is equally fundamental to all appliance design. Elastic traction whether by rubber bands, elastic thread or tape is a single concept and since the headgear was introduced it has varied little. The use of inclined planes on plates or blocks or cribs is standard.

In 1900 Dr. Angle was discussing appliances and said,[4] "One surprising feature of the history is the frequency of the rediscovery of identical principles, their materialization differing only in minutiae of manufacture." We can repeat his statement today. Studying the orthodontic literature of the past provides a continuing source of amusement and amazement for the same old gadgets and methods keep cropping up proving that very few of us ever have a really original idea. To illustrate this let's look at a few of these old chestnuts.

The W shaped lingual arch has appeared and reappeared and usually is taught to students and given the name of a prominent orthodontist who uses it. In 1893 it was called the Angle device (Fig. 1). At the same time, the same principle in removable appliances was called the Coffin Spring. In my school it was called the Porter arch and in the West it is often called an Atkinson arch. In the early 1900's Case was using this headgear (Fig. 2).

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-05-14 via free access

FIG. 44.



Angle Device for Expansion.

Fig. 1 From Guilford, 1893.

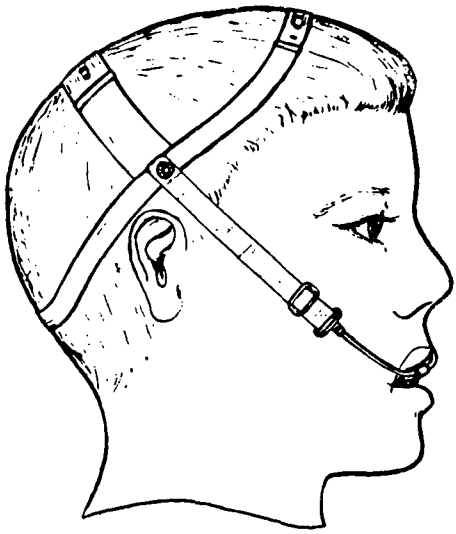


Fig. 2 From Case, 1908.

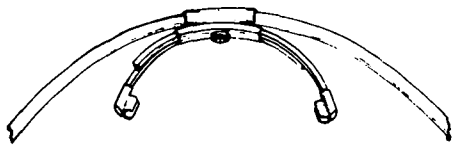


Fig. 3 From Case, 1908.

FIG. 135.

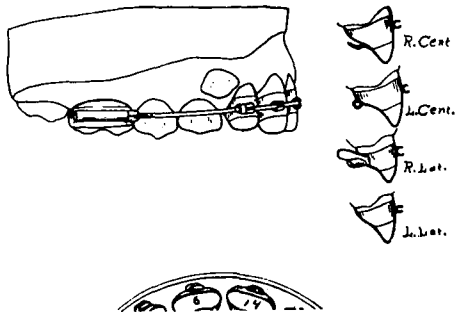
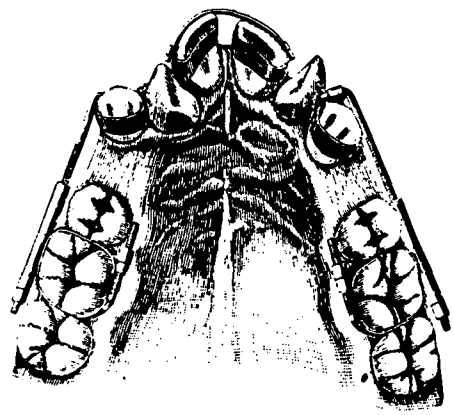


Fig. 4 From Case, 1908.

Is this reminiscent of our modern high pull gears? Does this look like a face bow known by another name today (Fig. 3)? It has been said that the McCoy open tube gave Dr. Angle the idea for the edgewise bracket—this is doubtful for Case was using such bands in 1900 (Fig. 4) and we know that Case and Angle knew each other's work. Just incidentally, Dr. Angle was using sectional arches on extraction cases in 1890 (Fig. 5).

Now the proper response to this information may well be so what? Just this, too many orthodontists today either don't know or have conveniently forgotten the basic mechanical prin-

Fig. 82.



Backward Movement and Rotation. (Angle.)

Fig. 5 From Guilford, 1893.

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-05-14 via free access

ciples involved in all orthodontic appliances and consequently no longer apply them. We all learned early in school that to each action there is an opposite and equal reaction, but we also were taught that a very small force applied through a sufficiently long lever could produce tremendous resultant changes. We learned that the inclined plane, the lever, the pulley and wheel, the axle, the screw and the wedge were the foundations upon which all machines were built.

In recent years there almost seems to be a campaign to deprecate the skill of the mechanic in dentistry. The chairman of the orthodontic department at one of our universities recently said,[5] "The effective use of good appliances is as essential to orthodontics as breathing is to living *but* it is a means to an end, not an end in itself, and our real problems do not lie in that area." Many more of our professors feel the same way. There has also been a good deal of public hand wringing about our professional problems with transfer cases—if all orthodontists were following sound mechanical principles most of these problems simply would not exist.

The average orthodontic curriculum assumes that the student thoroughly understands mechanical principles and plunges into the growth and development as though the successful movement of teeth was a byproduct of our efforts. The student is thoroughly impressed with the importance of being able to trace a headfilm and compare it with somebody's analysis and come up with a treatment plan without being properly impressed with the fundamental necessity for controlling tooth movement with the tools at hand—the orthodontic appliance. As a result, such a basic guide as Newton's first law of motion is frequently forgotten. For example, completely ignoring the clinical knowledge of the strength of the cuspids, if we assume equal and opposite action to be true, we know that at least more teeth must be incorporated in the so-called anchor unit than in the unit to be moved. But time and again we see practitioners pitting the six anterior teeth against two bicuspids and two molars in extraction cases and, even worse, pulling simultaneously against the weakened anchorage with Class II elastics. It is not necessary to adopt Tweed's ideas of anchorage preparation to realize that the mandibular buccal units will fail and move mesially producing an eventual failure in an otherwise well-conceived extraction case. Many years ago Stanton worked out the resistance offered by different teeth and even this bit of assistance is largely lost today.

Think now—what was wrong with the last transfer case about which you were unhappy? To begin with, I suspect that even if it was a so-called edgewise case that it was not completely banded to really take advantage of this beautiful appliance. Every appliance has good points but when the total appliance is not in place, how can it be fully utilized? We see edgewise cases with no bands on bicuspids or second molars, twin arch cases with no anterior bands, headgear appliances with dead coil springs—how can they work?

We see edgewise cases fully banded with neither eyelets, Lewis levers nor twin brackets—how can one control rotations? I would be ashamed to call myself an orthodontist if I couldn't handle several appliances but what if the total appliance is not even completely assembled or constructed? No, I don't believe that any amount of pious preaching about public opinion will solve our transfer problems. We need to look within ourselves to see if, in our eagerness to hasten matters

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-05-14 via free access

and handle more cases, we are leaving out essential mechanical parts of this appliance with which we propose to correct a malocclusion by mechanical means.

More emphasis should be placed in our meetings and in teaching on the basic mechanics of tooth movement, on the value and use of levers and leverage and the other means of mechanical advantage. Every appliance employing a band and one archwire utilizes these principles. It is true that the functional jaw orthopedics practiced in Europe do not, but not many of us as yet have adopted those methods.

The fine orthodontic results seen across America today are the result of superior technical procedures developed by outstanding mechanics in our profession. The literature of recent years is replete with learned papers explaining why Tweed gets the results he does or why the Kloehn approach elicits its response. One can find hundreds of such words of explanation and records but no biological research which has led to a methodology which we could follow.

In fact, the efforts to reduce biological research to clinical practice is currently raising a dangerous problem. There is a strong tendency today for clinicians to use the cephalometric headfilm as a direct and often principal diagnostic tool. The film is traced, the angles and lines measured and carefully charted and compared with one of several popular standards. Then this comparison alone is frequently used as a final decision as to method and rationale of treatment. Time and again it has been shown that biological and physiological norms are extremely difficult to establish and that the best are only useful as guides or aids in all parts of medicine. Perhaps in time the headfilm could be the sole diagnostic tool but today it should be used with judgment as one of the battery of tests to determine proper diagnosis. Study of the face, the total head, the relationship of the parts of the face and, by all means, the parents and other members of the family as well as models, photos and x-rays to determine the best approach to treatment is essential. Frequently such careful examination will show that the headfilm alone gives an erroneous and misleading answer but when used in conjunction with other guides will give completely reliable information.

Now a word about some fundamental actions and reactions and their continuous use in practice. Many texts show the classic illustration which demonstrates the pull of a Class II elastic over the end of a lower archwire, elevating the distal of the last banded tooth and tending to tip its roots distally. Yet good mechanics show this fault can be largely overcome by proper placement of a hook on the mesiogingival corner of the band. The old timers knew a lever could really rotate a tooth and Paul Lewis has brought the lever up to date with his bracket.

One could spend an hour showing old headgears and their modern duplicates. The laminated arches of today are a sound application of a well-known principle.

So what's new? What can be done to improve our mechanical methods? I predict that the next great step in orthodontics will be a proper adhesive to free us from the tedium of band construction. Brackets or other attachments will be placed directly on the teeth. Modern technology has produced a wide new spectrum of adhesives including the epoxy resins which have tremendous strength under all conditions. Some are dangerous in the mouth while others are simply too strong. In other words, once the bracket or attachment is fastened to the tooth,

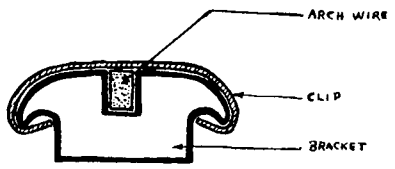
Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-05-14 via free access

there is no easy method of removal short of grinding it off. Unquestionably these technical problems can be solved. Surely we can produce an adhesive and a solvent which would adhere rapidly to dental enamel and metal, be insoluble in the mouth yet readily soluble by proper solvents. The fact of the matter is that all of our present dental cements are cohesive in nature and not adhesive at all. They principally act to fill the space between band and tooth, or between inlay and tooth—not to actively perform a fastening or sticking function. Development of an adhesive material which would be safe to use in the mouth, insoluble by saliva, soluble by solvents and with tremendous strength would not only revolutionize orthodontics but the whole field of operative and restorative dentistry as well. Believe me—it's overdue.

Since man first ligated teeth with grassline there have been few improvements in the fastening department. The pin and tube appliance was one variation; the lock pins on the ribbon arch were another which was copied in the Universal appliance.

The McCoy open tube is a variation but the present edgewise appliance takes us right back to the old tying procedure. The most effective closure on an orthodontic appliance today is seen in the Johnson lock and cap. Yet this could be greatly improved. The wide use of staplers in American industry today could show us the way. Why not a staple to fasten our archwires in place such as this (Fig. 6)? With all of our fine prefabricated appliances and attachments, we are still held back at the point of delivery by an old tedious method. Perhaps one of us will devise a completely new bracket and a method of closure.

Elgiloy is a step toward better alloy materials for arches and wires but new and better materials will come. The



PROPOSED MECHANICAL CLIP FASTENER TO REPLACE TIE WIRES ON BRACKETS IN CURRENT PRODUCTION

Fig. 6

billions expended on metallurgical research for rocketry has resulted in fantastic strides but these advances are simply not available to us because dentistry does not have the organization within industrial groups to exploit these discoveries. While large corporations spend millions to produce a new antibiotic or other medical product, the dental industry rarely, if ever, develops new products. Usually some self-sacrificing practitioner brings forth the new method or material to have it produced and sold by the dental manufacturers. And the manufacturers of dental products cannot be blamed for their market is too small to warrant expenditures of large sums on research and development. The returns would not justify the price to the stockholders. If a fraction of the biological research in orthodontics were directed toward our mechanical problems, progress could be greatly hastened. Unfortunately, far too little university or other research funds find their way from the natural sciences to the physical sciences where dentistry is concerned.

I would like at this time to pay tribute to all those who are struggling to change biology through mechanics. It has been the intent of this paper to re-emphasize the purely mechanical part of orthodontics. The manual ability of the orthodontist is of the greatest importance. The profession of dentistry and the specialty of orthodontics have both enjoyed a meteoric rise in twentieth century America and the high acceptance accorded to Amer-

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-05-14 via free access

ican dentists throughout the world is based on their ability to do the job superlatively. To me this is a part of the unique mechanical talent so widely exhibited in all phases of American life. This phase of practice should never be subordinated to the perhaps more esoteric portions which are, after all, only curtain raisers to the main event — successful tooth improvement.

2430 L Street

BIBLIOGRAPHY

1. Angle, Edward H., Treatment of Malocclusion of the Teeth and Fractures of the Maxillae. *Philadelphia, S.S. White,* 1900.
2. Case, Calvin, Dental Orthopedia. *Chicago, C.S. Case,* 1908, 406p. (p.1).
3. Webster's Collegiate Dictionary. 5th ed., *Springfield. G. & C. Merriam,* 1946.
4. Angle, Edward H., Treatment of Malocclusion of the Teeth and Fractures of the Maxillae. *Philadelphia, S.S. White,* 1900.
5. Moore, Alton, W., Observations on Facial Growth. *Am. J. Ortho* 45:399-423, June 1959.

DISCUSSION

Dr. R. H. W. Strang

To those of us who claim to be only clinical orthodontists, Dr. Parker's paper has an appeal that probably is more intimate than may be the case with others. Personally, I think it to be a very timely presentation. It certainly recalls memories of errors made in my own practice and errors that have been seen in referred cases.

Dr. Parker emphasizes the need for employing all available auxiliaries for case study previous to treatment. He then calls attention to the fact that the data thus obtained tells us only what has led up to the malocclusion and what has to be done in treatment but offers no information relative to how the corrective procedures are to be performed. Certainly all this knowledge without a thorough understanding of mechanical principles is wasted as far as the welfare of the patient is concerned.

However, we must also bear in mind that the most expert mechanic, even though he be a graduate of the best engineering course in the whole United States, would be a very dangerous orthodontist if he did not have the biologic foundation so essential to our special field of practice. Certainly the "what man" without the "how" and the "how man" without the "what" are equally unbalanced.

Force is an ever present phenomenon in the anatomical area in which we work and is the agent that we use in our corrective procedures. We certainly cannot learn too much about its presence in Nature's hands or in its use by *our* hands and brains.

Dr. Parker's historical review of appliances was interesting and enlightening. Simplicity of design in appliances was constantly preached by Dr. Angle and, of course, brackets cemented to the teeth would be a simplification. However, they would only be the handles for attaching the force application and would not reduce the necessity for a complete understanding of anchorage problems and cellular response to applied force.

This is not a paper that is open to constructive or adverse criticism but rather is one that is timely and commendable. Furthermore, there is one sentence that bears repeating in this discussion and I shall make it the final one of my review. Here it is: —

"We need to look within ourselves to see if, in our eagerness to hasten matters and handle more cases, we are leaving out essential mechanical parts of this appliance with which we propose to correct a malocclusion by mechanical means." And, I might add, there is the ever-present danger of omitting the finishing details in tooth adjustments that mean so much in stabilizing the final result.

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-05-14 via free access