

claim to see more rapid response and shorter treatment times. But, even better, I have seen beautiful tissue responses and less pain in my patients.

I have been a clinician for over 35 years, and my staff jokes about the pile of journals in my office. At any time, I have at least 10 to 15 journals on my desk to reread before they go on my shelf. That shelf is an active library of the *AJO-DO*, the *Angle Orthodontist*, and the *Journal of Clinical Orthodontics* going back a long way (thanks to my partner, the late Jerome Rogers). I also find Internet sources such as PubMed a wonderful addition to our access to a knowledge base that includes world-wide journals, both dental and medical. The great thing about the Internet is that we can bookmark and place references on our "favorites" list. Those journals hold a wealth of information on the reaction of apoptic cells to mechanical distortion. The resulting acceleration in cellular response is amazing. One easy example for any clinician to search would be "cellular wound vac" (or the like) and start reading of all the phenomenal findings in the world relating to cytoskeletal changes in those very same leukocytes that we are causing to change in our patients with our treatment modalities.

Knowing the histologic effects of ischemia and hyalinization on the cells of the PDL, cementum, and adjoining bone, aren't we supposed to be getting as far away from intermittent, heavy forces as we can? Why would the modern practitioner ever want to place a .014-in archwire in an .018 × .022-in edgewise slot in a crowded dentition to level and unravel? Hey, let's increase the friction and force even more! Let's use some of those elastic ligatures that appeared on the orthodontic market without research data in our journals about their effect on friction and forces. Of course, later on, thankfully, we learned a lot about their rate of deterioration.

In closing, I challenge Dr Burrow. As a clinician, have you ever treated a patient with the Damon system? Have you carefully sequenced the arches in the early stages of leveling to maintain as much of a light, continuous force as possible, not only to eliminate notching in the arch, but also to avoid distorting the apoptic leukocytes beyond the 5% to 20% range for optimum cellular response as does the subatmospheric pressure of wound healing that physicians practice? Have you then sequenced into the graduated rectangular wires that promote second- and third-order control? Have you not only done this, but done this in a fraction of the time it takes for conventional appliances with elastomeric ligation? I have, after years of learning from Andrews, Begg, Alexander, Haas, Cetlin, Roth, McNamara, Sondhi, and many others. But I have also learned the big picture from Moorrees, Harvold, and Moss and the ever-important histologic picture from Rygh and Salentijn.

Finally, I do agree with one of Dr Burrow's positions. I also commend the late Dr Robert Kusy for all his work.

This is my own perspective. Each of us has his or her own. Don't take my word, either! Please take what I've said and go back to this article. Do not flip through it like you would *People Magazine*. This is a professional journal. Read it. Analyze it.

Refer to the articles and quotations listed. Think for yourself. This is what I will do when I return to my office next week.

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Author's response

I thank Dr Bach for his passionate response to my recent article.¹ There is much misunderstanding and misinformation regarding resistance to sliding and the importance of the biologic response. I will respond in the same format as Dr Bach.

First: Dr Bach complained that I limited "the entire friction discussion to binding during sliding mechanics." Yes, my article was about resistance to sliding, not leveling. The title of the article is "Friction and resistance to sliding." Dr Bach also asked, "What is binding?" and then gave a partial definition of friction. I defined binding in my article: "Binding is created when the tooth tips or the wire flexes so there is contact between the wire and the corners of the bracket." This creates a moment of a couple (M_C) to counter the moment of a force (M_F). As the bracket (tooth) moves in the direction of the force, the binding forces increase, and friction has little influence (even at the beginning of movement). Friction is measurable in laboratory studies because the bracket is stabilized and the wire is pulled through it; this, however, does not happen in orthodontics because, when a force is applied to the tooth by a bracket, the tooth moves (the tooth, dental complex, bracket, and wire are not fixed). Tooth movement in orthodontics is a quasi-thermodynamic process, which means that the teeth move slowly; actual tooth movement is not like manually moving a bracket down a wire. The limiting factor of tooth movement is not friction, but biology. Dr Bach contended that "there is no binding effect in orthodontics without friction." But he is confusing friction and binding. Friction can only be measured empirically (it is not a fundamental force; it is derived from electromagnetic forces between atoms, so it can't be measured mathematically). As the tooth tips the wire contacts the edges of the bracket (active stage) and a moment of a couple is created (M_C). This M_C can be mathematically determined ($M_C = \text{Force} \times \text{distance}$). These are both parts of the equation of resistance to sliding, but different concepts. Dr Kusy's research shows how insignificant friction is as the tooth moves and θ increases. Dr Bach continued, "Don't Burrow's own graphs show that, with the lighter .014-in wire used in initial leveling, there is so little friction in the PSL that it is barely measurable?" Actually those graphs were based on the work of Thorstenson and Kusy, and, in the friction graph, the wire/bracket assembly was not allowed to move; this does not happen in clinical orthodontics.

Second: Dr Bach objects to my using the overall conclusion of Pandis et al,² that "no difference in the time required to correct mandibular crowding with Damon 2 and

conventional brackets was observed." Dr Bach says I should not have left out the statement that "patients with moderate crowding . . . were finished 2.7 times faster than those treated with conventional brackets." I chose to use the overall conclusion, not 1 specific fact. Bach says that "the quote taken by Dr Burrow was for statistical difference in the least crowded patients in study (ie, 2 mm)." In fact, Pandis et al reported that "this difference was insignificant for subjects with severe crowding (irregularly index >5)." Dr Bach said that he uses the research of Pandis "to argue the advantages of PSL in many patients with crowding." He evidently forgot the discussion portion of the research, in which Pandis et al reported that "our findings agree with previous trials that found no difference in the crowding alleviation stage at predetermined times with conventional and self-ligating SmartClip brackets (3M, Unitek, Monrovia, Calif)³ or conventional and self-ligating Damon 2 brackets."⁴ Pandis et al also referenced Torres et al,⁵ who reported "no difference in treatment duration between Damon 2 and Synergy brackets (Rocky Mountain Orthodontics, Denver, Colo) with a maxillary, split-mouth setup." Pandis et al reported that "It is strikingly surprising that self-ligating brackets have been advocated and marketed long before the publication of any clinical trials investigating their efficiency by independent sources." Not exactly a glowing endorsement. Since Dr Bach wrote his letter to the editor, Fleming et al,⁶ in the May 2009 issue of the *AJO-DO*, compared the efficiency of mandibular arch alignment in 3 dimensions with a self-ligating bracket, SmartClip, and a conventional bracket, Victory series. The authors of this prospective, randomized clinical trial concluded that "alignment in the mandibular arch in nonextraction patients is independent of bracket type." The evidence continues to mount.

Third: Dr Bach was critical that I didn't review the biology of tooth movement; again, I assumed that all orthodontists understand these concepts, and it wasn't the essence of the article. Knowledge of moment-to-force ratios, load-deflection rates, type of materials used, size of wire, and so on are important, but these were not the focus of the article. In a side note, I just finished a research project comparing the rates of retraction of the maxillary canines when bonded with SmartClip, Damon 3, and a conventional bracket. The canines with the conventional bracket moved faster in 28 days than those with the SmartClip or Damon 3 statistically, but clinically

there was little difference. The conventional bracket was wider than the self-ligating bracket; this might be why the conventional bracket moved faster, but it appears that the limiting factor is biology.

In response to Dr Bach's final challenge, yes, I have treated patients with self-ligating brackets. My purpose in the article was not to promote any specific bracket and or put down a bracket system. A good orthodontist with knowledge of proper biomechanics (Moment ratios, load-deflection rates, materials, and so on) and diagnostic skills can obtain great results with most brackets, and I feel sure that Dr Bach's final results are just as good as he says they are.

I still stand by my final sentence, "The limited clinical trial data now available do not support the contention that treatment time is reduced (presumably because of lower friction) with self-ligating brackets."

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