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Taking stock: Hippocratic and Platonic thoughts on orthodontic tooth movement

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Professor Lysle Elwin Johnston, Jr. has always professed that orthodontics is a biology-based specialty. Unfortunately in the fist 100 years of the specialty, biology has not been able to affect the nature of orthodontic treatment. Will the next century be different? What could be the possible Hippocratic or Platonic approaches?

The Platonic approach is focused on the process whereas; the Hippocratic approach would advocate consideration of the total organism. In the Platonic sense the clinician would gain experience by repeating the process and design better mousetraps. How the newly designed mousetrap might affect the mouse or the person who is setting it up is not integral to the equation. The Platonic relationship focuses on the relationship (the process) rather than the person(s) involved. The Hippocratic school of thought, on the other hand, takes the patient as the hub of attention. It is not the mousetrap, *per se*, but how the organism is affected. Gadgets are not as important as the organism's response to the gadget. The 'bio' part of biomechanics is Hippocratic and the 'mechanics' Platonic. The clinician scientist has the choice to either design a better looped-wire or affect the remodeling response of the periodontal tissues. Is a re-designed mousetrap an advancement or (perish the thought) science?

Teeth are fundamentally dumb. They never know where the force is coming from. A rubber band is no different than a closing loop. But the periodontal

apparatus might have different ideas. As forces are applied these tissues PDL, bone, and gingiva remodel. But if the tooth is ankylosed then no remodeling can take place. Implants work on this principle. Thus, if the theory says periodontium remodels in response to force and it does not, no matter how sophisticated the new mousetrap design is, there will be no tooth movement. Furthermore, there is no evidence in the literature that the cells of periodontal tissues are capable of distinguishing between pressure and tension type forces. Alveolar bone trabeculae, for example, do not remodel and line up to resist the forces of orthodontic appliances (1, 2). It could the that not the bone, but the soft tissues are in control of tooth movement. In fact, the resistance of gingival tissues might be more significant than that of bone (3).

We were the first to notice that tooth movement is the end product of an inflammatory response of periodontal tissues. Inhibition of the inflammatory process diminishes the rate of tooth movement (4). Clearly, the inflammatory process requires increased vascular activity. As the tissues become hyperoxic or hypoxic, remodeling is affected (5). Additionally, we have been shown that the ambient oxygen tension affects the osteoblastic phenotype in a ying/yang manner (6). Unfortunately, it has been difficult to modulate the vascularity of the periodontal tissues. But in fracture healing the ultrasound promoted faster healing and with increased vascularity (7). *In vitro*, gingival fibroblasts and osteoblasts respond to ultrasound with an increased inflammatory activity. Disappointingly, clinical application of ultrasound did not result in any enhancement or the rate of tooth movement; it is difficult to estimate the optimum intensity, frequency, and rate and duration of ultrasound application in periodontal tissues (2).

Despite these setbacks, in the animal model, we have been able to immunohistochemically demonstrate that upon tooth movement nitric oxide (NO) synthesis is increased. In the PDL of stationery teeth, blood vessels show no staining, but around the moving teeth, these tissues are heavily stained both with heavy and light forces (8). Nitric oxide is a very significant and potent molecule. Its physiologic functions range wide: regulation or vascular tone, host defense, cell differentiation, penile erection, inflammation, apoptosis, to name a few. It is not beyond reason to think in the future there might be a Viagra for teeth; there may be NO magic pill–pun intended.

Building on our earlier findings we examined if the hormone known as the pregnancy hormone (relaxin) might have a loosening affect on the sutures of the craniofacial complex. Relaxin is released just before childbirth to loosen the pubic symphysis. The relaxed suture allows for the widening of the hip in the mother and the fetus could pass through the birth canal. It was our contention that if the sutures could be loosened and then orthodontic forces applied, movements are likely to take place faster and be more stable. Both males and females possess receptors to this hormone.

Our experiments to answer these questions were conducted in organ culture. Relaxin was added to the mouse calvariae and mandibles. Presence of relaxin abolished the integrity of sutures. Both in the cranial sutures and PDL, the organization of fibers were totally gone. This hormone also exhibited (somewhat dose-dependent) metalloproteinase activity (9). It might just be possible to apply relaxin to the surrounding tissues of orthodontically moving teeth to reduce treatment time and increase the success of retention. When it happens (either relaxin or nitric oxide application) it will be the first ever application of biology in orthodontic treatment.

Professor Johnston has brought the specialty to this turning point. The integration of Platonic and Hippocratic ideals will be fun for the young generation of orthodontists. It is like designing and engineering an automobile. The finely designed, manufactured and tuned suspension (a Platonic exercise) will not make a driver win a grand prix championship. But the driver organism can never become a champion driver (a Hippocratic postulate) without the superior suspension.

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