It is a great time to be an orthodontist! Just shy of 20 years ago, I completed my specialty training and entered private practice. With an abundance mindset and a blank slate, challenge and change provided opportunities to innovate and differentiate. Soon after graduating, I founded BAS Medical, a company with a mission to accelerate treatment and improve stability in retention. Its premise was a continuation of the research I began during residency for my master’s thesis. Promising findings with a naturally occurring hormone shifted the company’s focus from orthodontics to cardiovascular. It grew, later becoming Corthera, which after completing FDA approved clinical trials was acquired by Novartis. It was an eye-opening experience to see first-hand the exorbitant risk, cost and regulatory obstacles that come with bringing new products to market.

When Invisalign therapy came to market, I was drawn to it in its earliest days. I saw the opportunity for what it was, an innovative new way to directly address a patient desire. I did not listen to naysayers. I did not look for the weakness. I adopted and adapted. With each new generation of innovation, I understood the tool better and was immediately prepared to maximise the improvements. This led to the opportunity to become an Align Tech Faculty member and later the privilege to participate in the Align Clinical Research Network focusing on product development and treatment protocols. Today, I, along with Dr Maz Moshiri, educate orthodontists from all around the world on how to achieve efficient, profitable, plastic-fantastic finishes through the Aligner Intensive Fellowship course (www.alignerfellowship.com).

When “vibration” was introduced to orthodontics at (30 Hz), my nature was to explore it. Upon investigation, I was surprised to find very little preclinical or clinical data supporting the device. More so, I was perplexed that its founding premise was the cranial suture response of rabbit premaxillae to 1 Hz vibration.1 I had several conversations with the same venture capital firms that invested in BAS Medical. This clinical leap of faith from cranial suture mineralisation at 1 Hz to orthodontic tooth movement at 30 Hz never made sense to me. The venture capital firms declined to invest. Even more surprising, I was later provided two new science-proof sources. One concluded that the (30 Hz) vibrations were drastically impacted by biting force.2 The other concluded that the (30 Hz) device “actively inhibit osteoclasts”.3

At around the same time, I heard of micro-osteoperforation (MOP) from Propel Orthodontics. The economics alone made MOPs much more attractive to me than passing through a US$1,400 at-cost adjunct, with little to no supporting data. I knew MOPs to be on solid ground, backed by over 100 years of science. The method was easy to learn and dramatic results became immediately evident. I particularly liked that MOP is doctor-controlled, allowing me to leverage my knowledge of aligner mechanics and target the treatment to specifically where needed, rather than rely upon a patient-controlled 20-minute daily regimen. Here again, with each new generation of innovation, MOP delivery has become easier and faster. With the release of the motorised driver, MOP has become near effortless.

Later, a new form of vibration entered the market. It was high-frequency vibration (120 Hz), offered by a company I had come to know and trust. Again, my curiosity drove me to investigate it, however, with heightened scepticism. I did not use the new high-frequency device on my patients for over a year, until I had educated myself on what vibration really was and did. In doing so, I found high-frequency vibration to be backed by a robust preclinical and clinical development programme. Unbeknown to me, a methodical investigation had been underway for many years examining multiple vibration profiles, specifically targeting dental and orthodontic applications.4–6

While some dismiss preclinical studies as not the same as use in humans, I understood their importance from my previous research experience. This is where solid science begins. In order to predictably change the biology of tooth movement, the mechanism of action and target cells must first be identified. Alikhani et al. did just that. Their research then isolated and investigated the three independent components of the vibration profile (frequency, magnitude and time) and discovered that different frequencies produced different results.4,5,7 Even more telling was the discovery that high-frequency vibration acts differently whether in the absence or presence of orthodontic force (inflammatory baseline condition). This landmark research had achieved what I had at-
tempted so many years before: the researchers had identified and tuned an adjunct not only to accelerate orthodontic tooth movement, but to offer promise of stability in retention as well.

Preceding the launch of high-frequency vibration, a narrative was forming that “vibration doesn’t work”. This was based on multiple studies demonstrating that low-frequency vibration (30 Hz) delivered no significant clinical benefits with regard to orthodontic pain or tooth movement. However, in 2014, the National Aeronautics and Space Administration (NASA) published vibration research differentiating low- versus high-frequency vibration that cited the mathematical law that a strain stimulus is a function of both strain magnitude and frequency and further stated, “Bone response to mechanical signals seems to correlate to increased frequency.”

In 2017, a head-to-head comparison of the two commercially available devices was performed, again in a university research environment. In agreement with the NASA research, Judex and Pongkitwitoon found the device with higher magnitude and frequency to produce greater cellular response and concluded, “The difference in vibration profiles induced by the 2 devices is striking.”

Based on supporting science, I am now comfortable with prescribing either MOP or high-frequency vibration. Beyond the clinical benefits, they influence referral network discussions. A referring doctor planning the treatment of an implant case may require space creation through pre-restorative orthodontics. Delivering consistent, efficient, predictable set-ups in a short time makes the phone ring. Let’s look at a few ways I have used these tools, including combining their effects to help meet collaborative clinical goals and satisfy patient desires.

Case 1

The patient had elected to receive cosmetic restoration of anterior teeth (Fig. 1a). Pre-restorative orthodontic treatment was performed to expand the arches and intrude anterior segments. VPro high-frequency vibration...
(Propel Orthodontics, Ossining, NY) was used in conjunction with a seven-day aligner exchange interval despite moderately difficult, and advanced difficulty movements flagged blue and black respectively. Twenty-one stages were completed in 5 months with no refinement. The patient was ready for restorations after a total of three office visits (Fig. 1b).

Case 2

Retreatment of a 17-year-old patient to correct an overjet Class II end-on malocclusion (Figs. 2a & b). Intrusion of maxillary and mandibular posterior teeth with Class II elastics was obtained. Despite flagged challenging movements, VPro high-frequency vibration was prescribed and seven-day aligner exchange intervals were maintained. Treatment was completed in nine months with no refinement and no centric relation–centric occlusion slip upon occlusion, and after a total of five office visits (Figs. 2c & d). The use of VPro was continued in retention for two months. The one-year follow-up shows a stable Class I occlusion, and the improvements in profile had been maintained (Fig. 2e).

Case 3

The patient desired an accelerated pre-prosthetic set-up (Fig. 3a). With challenging torque and intrusion required and limited clinical crown surface owing to excessive wear, I prescribed combination therapy: MOPs to prime the system proactively, facilitating advanced-difficulty intrusions and root torque; and VPro high-frequency vibration to enhance and prolong the inflammatory response to MOPs, while maximising clear aligner fit and forces. One set of additional aligners was ordered, but no additional MOP treatment was needed. The patient reported no problems with 5-minute daily use of VPro, and treatment was completed and the patient was ready for restorations in eight months, after a total of five office visits (Fig. 3b).

Case 4

The patient presented with mandibular crowding, including a blocked-out lower right canine (Figs. 4a & b). I proactively prescribed and delivered two interradicular MOPs distal from mandibular second bicuspid to second bicuspid, along with extraction of a mandibular incisor. I also initiated high-frequency vibration proactively with the first aligner to ensure maximum seating for advanced canine root torque and maintain the inflammatory response to MOP. One set of additional aligners was required and treatment was completed after 7.5 months and required five office visits (Figs. 4c & d).

The clinical landscape is changing before our eyes, and the opportunities presented will continue to accelerate. For those who embrace change and are willing to adopt and adapt, it is truly an exciting time to be an or-
thodontic specialist. A practice with a scarcity mindset will progressively date and starkly separate from those who innovate. It is difficult to fathom that after 20 years there are still so many with folded arms and furrowed brows, holding strong to the notion that “plastic could never work”. With similar conviction, there are just as many who will bypass the literature and conclude that “vibration doesn’t work”, because their colleague read it on a blog.

What makes high-frequency vibration stand out for me is the proving ground that preceded its launch within a university research environment. In an era where product launches seem to precede product development, it is refreshing to see technology tested and developed in this responsible fashion. As a sceptic who does not incorporate technologies without thorough vetting and
In this chapter of modern orthodontics, it has been interesting to watch how two different companies treat and serve their customers. High-frequency vibration shook the market when it entered, but high science and downward price pressure made orthodontic predictability and comfort an option for all, rather than just the wealthy. As orthodontists, we know the importance of delivering not only great results, but also great customer service. The low road has been increasingly the road less travelled, while choosing the high road has made all the difference.

Dr Jonathan Nicozisis has practised orthodontics since 1999 in Princeton in the US. He completed his dental education at the University of Pennsylvania in Philadelphia in the US before attending Temple University, also in Philadelphia, for his orthodontic residency. Dr Nicozisis is a member of the Edward H. Angle Society and Invisalign national speakers’ bureau and clinical research network. He is the founding orthodontist and a former scientific advisory board member of BAS Medical (later Corthera and acquired by Novartis in February 2010), a development stage company founded in 2003 with a mission to develop and market a novel technology to accelerate and improve the stability of orthodontic treatments. His master’s research on the use of the hormone relaxin as a therapeutic adjunct was the basis of BAS Medical’s innovative research. Dr Nicozisis serves on the scientific advisory board of Propel Orthodontics, a rapidly growing biotech company developing novel technologies to improve oral health. In 2014, he co-authored a textbook chapter on Invisalign with the former chairman of Temple University’s Department of Orthodontics and Align Technology’s director of research and development. Dr Nicozisis is a consultant to Smile Assist and Your Ortho Coach. Most recently, he founded the rapidly growing Aligner Intensive Fellowship Course, in partnership with Dr Maz Moshiri.

References: