Accelerated treatment modalities in clear aligner treatment

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Adopting new technologies is critical to any orthodontic practice that aspires to expand and innovate in the twenty-first century. Responding to patients’ evolving needs is vital to establishing patient satisfaction with treatment and subsequent practice success. Accordingly, the capacity to offer patients unique treatment benefits that specifically address their principal concerns, is perhaps one of the most important driving forces to incorporating acceleration technologies and adjunctive treatment modalities into practice. Significantly, when these technologies are used in combination with other innovative treatments, such as clear aligner therapy, the resultant synergy can potentially result in markedly improved and timely treatment outcomes. Such is the case, I believe, with micro-osteoperforation (MOP) for acceleration of orthodontic treatment, and high-frequency vibration (HFV) for enhanced clear aligner seating and pain/discomfort reduction.

I have found MOP to be clinically effective in acceleration of treatment and in enhancement of clinical results for a broad range of malocclusions, including crowding, space closure, molar uprighting, rotations, intrusions and extrusions.1–3 A research survey of adult patients has indicated that a majority were interested in any procedures that could effectively reduce their treatment time.4

My decision to implement MOP in my own treatment procedures arose from increasing requests from my patients to reach their orthodontic aesthetic and functional goals, within a time frame that aligned with their expectations as well as their own estimated capacity for compliance with treatment. Even with Invisalign’s current seven-day aligner exchange protocol, patients have expressed interest in further truncating their treatment time, without increasing the discomfort sometimes associated with tooth movement. MOP has proven to be instrumental in addressing these patient concerns in my practice. It can be performed chairside within several minutes using the Excellerator PT power driver with the disposable surgical grade Excellerator PT power tips. I find predictability and confidence in knowing this device is specifically designed and indicated for performing multiple micro-osteoperforations in a single treatment. The procedure can be applied in both fixed and removable orthodontic appliance therapy, but is especially dramatic in its capacity to impact clear aligner treatment.

The science underlying MOP is based in orthopaedics dating back over 100 years. In 1989, Harold Frost coined the term “Regional Acceleratory Phenomenon” (RAP) to describe this predictable remodelling response of bone to iatrogenic stimuli. Its premise suggests that disruption of the cell membranes of osteocytes, the most ubiquitous cell in bone, stimulates their secretion of a cascade of cytokines and chemokines that accelerate the physiological rate of bone remodelling.5–7 As research has demonstrated that the rate of tooth movement is dependent upon the rate of the physiologic process of bone remodelling, it is reasonable to surmise that an increase in the rate of bone remodelling should correlate with an increase in the rate at which clear aligners can be exchanged.3, 6–8 Use of the Excellerator PT device to create micro-osteoperforations of the cortical plates of interseptal bone activates a chemically-based natural immune response, that accelerates bone turnover and subsequent tooth movement when orthodontic forces are simultaneously applied.5, 6

The procedure conducted under topical, or local anaesthetic imparts minimal discomfort to the patient. To further mitigate any potential discomfort, the patient is instructed to take 1,000 mg of Tylenol one hour prior to the appointment. In preparation for conducting the MOP, a topical anaesthetic gel (12.5% lidocaine, 12.5% tetracaine, 3.0% prilocaine and 3.0% phenylephrine) is sparingly applied and is supplemented with local infiltration anaesthesia using Septocaine (4.0% articaine HCL and epinephrine 1:100,000) in buccal and labial vestibule if needed. Following MOP, the patient is further directed to take 500 mg of Tylenol (acetaminophen) every six hours for the next 24 hours to alleviate any residual discomfort associated with the procedure. Significantly, a majority of patients have reported that they did not require the use of any post procedure analgesics.

Case 1: MOP can especially be used effectively in conjunction with clear aligner therapy. For example, in Figures 1a and b, a 19-year-old female patient presented with a vertical Class II skeletal malocclusion four years post fixed appliance treatment. She demonstrated clinically a retrognathic chin point, an anterior open bite with inadequate incisal guidance, and dark buccal corridors. A treatment plan including adjunctive MOP therapy in conjunction with Invisalign Teen treatment was accepted by the patient, with the patient caveat that no elastics
would be used and that the treatment would be completed in 12 months. The treatment plan included creating graduated Curves of Spee in both arches by means of maxillary molar and second bicuspid intrusion and mandibular first molar and second bicuspid intrusion, following one of Dayan’s posterior tooth intrusion protocols for anterior open bites. The intrusion mechanics were anticipated to generate a mandibular hinge axis of closure that would create a forward projection of the chin point to improve the patient’s profile and establish incisal guidance while respecting the patient’s maxillary incisal display without the use of elastics. The anticipated forward projection of the mandible offered the secondary benefit of applying interproximal reduction to the proclined mandibular incisors to create space to upright these teeth to an improved position, and to increase the overjet through incisor retraction to accommodate the forward projection of the mandible. In addition, a broadened arch form was expected to be created to address the dark buccal corridors without concern for opening the patient’s vertical further, by virtue of the occlusal coverage afforded by the aligners as well as the adjunctive treatment. The maxillary incisors were extruded less than 1 mm to establish an aesthetic smile arc.

In order to support the intrusion mechanics, MOP was conducted in both arches and supported further by the patient’s use of rubber gum. Figures 1c–e illustrate the number and position of the perforations conducted. In addition, MOP was also conducted distal to the maxillary second molars to maximise molar intrusion. Treatment with 49 aligners was completed (Figs. 1f–h) in seven months and three weeks on a schedule of three- to five-day aligner exchanges, dependent upon the patient’s own determination of appropriate aligner tracking. Based upon experience with cases of a comparable nature where MOP was not used, use of MOP in this patient resulted in exceptional and uninterrupted aligner tracking, achievement of all treatment goals to the patient’s satisfaction, and a treatment time truncated by approximately five months.

**Case 2:** Occasionally, more complicated cases will require more than one MOP procedure. In my experience, the average MOP procedure will permit a three-
day aligner exchange from three to four months. Where cases are anticipated to extend beyond 50 aligners due to more challenging tooth movements, I then incorporate a second MOP procedure into the treatment plan. For example, in Figures 2a and b, a 28-year-old male patient presented for orthodontic consideration with a vertical Class III skeletal malocclusion characterised by bimaxillary arch constriction, an anterior/posterior crossbite from the left lateral incisor to the left second bicuspid, retroclined and extruded mandibular incisors, a mandibular shift to the patient’s left of 3.5 mm, a 1 mm overjet and a 10–15% overbite. A treatment plan including two adjunctive MOP procedures and Invisalign with 3/16 in., 6 oz Class III elastics was accepted by the patient. The treatment included broadening of the arch form, correction of the crossbite, intrusion of the mandibular incisors with the application of 15° lingual root torque, and intrusion of the posterior teeth to create a mandibular hinge axis of closure of the mandible, to achieve incisal guidance without altering the patient’s maxillary incisal display or extruding the mandibular incisors. In addition, an aesthetic smile arc was planned.

The first MOP procedure was conducted at aligner 1, and the patient exchanged aligners every three to seven days, dependent upon the patient’s own assessment of satisfactory aligner tracking throughout the initial set of 45 aligners. The second MOP procedure was conducted at aligner 1 of refinement (Fig. 2c), and the patient exchanged aligners at the same rate of exchange throughout the next 38 aligners. Following with a total of 83 aligners, the patient completed aligner treatment in 16 months.
Figs. 2a & b: Initial. Fig. 2c: Commencement of refinement prior to 2nd MOP procedure. Fig. 2d: Final.
(Figs. 2d–e), followed by an additional two months of elastic wear with four additional passive aligners (exchanged every two weeks), for a total of 18 months total treatment.

Although all patients are interested in reducing their treatment time, some are not amenable to MOP. For these patients, any adjunctive non-surgical device that has the potential to reduce treatment time by 25–30% has been demonstrated in surveys to be of interest. While the science supporting vibration as an adjunct for tooth movement is sparse, HFV technology appears to be a potentially viable alternative for these patients. Clinical experience has demonstrated HFV’s capacity to enhance aligner seating, which is particularly important with patients that fail to wear aligners the recommended 20–21 hours per day. The ability to progress treatment forward with less than fully compliant patients results in a reduction in mid-course corrections and refinements, and thus in effect secondarily reduces treatment time. Moreover, these devices have demonstrated the additional capacity to reduce the discomfort associated with tooth movement.

Case 3: The following example is illustrative. In Figures 3a and c, a 64-year-old female patient presented with a Class I malocclusion characterised by moderate incisor crowding, a 30% overbite and a 2 mm overjet. She initially agreed to MOP, but changed her mind at aligner delivery. In addition, she refused any attachments. However, she elected to use a VPro5, a high-frequency aligner seater device (Propel Orthodontics) for five minutes daily and to wear the aligners 21–22 hours per day. With a seven-day aligner exchange, her estimated treatment time was approximately eight months and two weeks. Treatment with 33 aligners was completed in five months and three weeks with a five-day aligner exchange, which is a decidedly 30% truncated treatment length when compared with the original anticipated treatment using a seven-day protocol. In addition, the patient indicated that the discomfort associated with new aligner exchange was immediately alleviated with the HFV seating device, and enabled her to progress with a truncated aligner exchange without discomfort. The patient was satisfied with her result and rejected any refinement.

Case 4: Over the past two years, I have used MOP in combination with the HFV aligner seating device. The following is an example of these cases. In Figures 4a and b, a 60-year-old female patient presented with a Class I malocclusion characterised by bimaxillary constriction manifested as severe maxillary and mandibular crowding, and a deep bite (80% overbite) with severely retroclined and super-erupted mandibular anterior, and a steep inter-incisal angle (158°) outside of the physiological range. The treatment plan included 3 mm intrusion of the mandibular incisors and 1 mm extrusion of the maxillary lateral incisors, to preserve the patient’s incisors display while creating an aesthetic smile arc. MOP was conducted from the distal aspects of the first premolar in both arches,
Fig. 3a: Initial. Figs. 3b & c: Final.
and supplemented with the use of the HFV device for five minutes per day. Prior to the procedure, the patient was instructed on recognising appropriate aligner tracking. As shown in Figures 4c and d, treatment with 79 aligners (43 initial, 22 first refinement, 14 second refinement) was completed in 13 months and three weeks (compared to the anticipated treatment time of 19.5 months without acceleration). The use of MOP in combination with the HFV device resulted in exceptional aligner tracking throughout treatment, patient comfort with the accelerated aligner exchange of every three to six days, and a treatment time truncated by almost six months.

Discussion and conclusion

In spite of a growing body of both laboratory studies and clinical reports investigating the effects of pulse vibration devices—both low- and high-frequency—
on the rate of tooth movement, the inconclusive and sometimes conflicting results, compounded by methodological heterogeneity, have made it difficult to critically assess the evidence. It is of critical importance to recognise this, in order to avoid misleading practitioners into promoting clinical outcomes to their patients that are specious. The paucity of high-quality randomised clinical trials is problematic. Moreover, this challenge is compounded by the trend of manufacturers directing patients to their orthodontic products rather than through orthodontic practitioners, as well as to selected clinicians that promote these products. An emergent scientific observation, for it to become an objective fact, whether or not it is accepted, requires more than a handful of selective scientific research. It requires a whole system of research all pointing in the same direction and towards the same consequences. In the absence of a body of science-based evidence, there, nevertheless, remains an increasing volume of clinical reports that illustrate the potential value of these accelerated modalities.

Precise aligner seating is not only integral to the clinician’s anticipated treatment schedule, but it also prevents teeth from moving in an undesired or unanticipated direction within the aligner, due to a less than adequate fit. Successful tracking is fundamental to accelerated aligner exchange. HFV pulse vibration devices such as the VPro5, have clinically demonstrated the capacity to enhance tracking and tooth movement, assuming appropriate diagnosis, treatment planning and Clincheck design.

An especially particular benefit of this HFV device is that patients only need to use it for five minutes per day, which is conducive to patient compliance. Moreover, it appears to be of benefit with tracking in patients that are less than compliant with the mandated 20 hours per day aligner wear protocol. A recent study demonstrated a significant 99.6% patient compliance rate with the five-minute HFV device. My own experience with a low-frequency vibration device wherein the manufacturer designated a mandatory 20 consecutive minutes of use, resulted in a compliance rate of only 10%, which led me to abandon its use.

During the first few hours or days of aligner exchange, some discomfort is expected. The HFV device has elicited a positive response from a majority of patients, with some patients claiming that its use immediately following aligner exchange, results in complete resolution of discomfort. Congruently, a recent study using the device in aligner therapy demonstrated a statistically significant immediate reduction in recorded pain scores, versus controls within five minutes of aligner exchange, as well as over a seven-day period following aligner exchange. Accordingly, it appears that many patients benefit from use of the device in discomfort modification.

Because the MOP procedure is entirely clinician-directed, it does not rely on patient compliance outside of the office to generate its effects. It therefore provides an opportunity to more readily appreciate its capacity to accelerate aligner treatment, and consequently remains the gold standard for acceleration in our practice. Moreover, based upon clinical experience, it appears that the combination of MOP and HFV devices provides a possible synergistic effect, where the capacity to exchange aligners every three days is extended over a greater period of time, as opposed to instances where MOP alone is used. The benefits of decreased treatment time with enhanced predictability and clinical outcomes are of importance to clinicians and patients alike. Within the past two years, we have experienced patients who have presented for treatment through patient referral, proactively requesting the MOP procedure as an adjunct to their aligner treatment. The use of these accelerated devices in clinical practice has the potential to augment the quality of care, patient acceptance of, and satisfaction with orthodontic treatment. Several years ago, these acceleration modalities had significantly influenced my practice. Now, they have defined it.

Acknowledgement

The Excellerator is the first and only device cleared by the US Food and Drug Administration (FDA) for microosteoperforation in orthodontic and dental operative procedures. Propel Orthodontics markets the VPro5, the first and only high-frequency vibration aligner seater. Propel Orthodontics provided financial support to the author.

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is a Top 1% Super Elite provider of Invisalign and has been an Elite provider since its inception. He has lectured across the US to doctors on all aspects of Invisalign treatment since 2004. In addition to his Doctor of Dental Surgery degree and Orthodontic Specialty Certification, Dr Brigham earned a Master of Science degree in Immunology at Case Western Reserve University in Cleveland, Ohio, in the US. For his research, he was presented with the Harry Sicher Research Award by the American Association of Orthodontists. A former Assistant Professor of Paediatric Medicine at the University of Illinois Medical Center in Chicago in the US, Dr Brigham currently serves as an adjunct professor and is the dedicated Invisalign and Propel instructor in the Graduate Orthodontics Program at A.T. Still University in Mesa, Arizona, in the US. In addition, he practises in Scottsdale and Cave Creek in Arizona, where he has treated 1,967 patients (including over 672 teens) with Invisalign.

Editorial note: A list of references is available from the publisher.