Non-extraction treatment of severe crowding with the aid of cyclic forces and corticotomy

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Introduction

The reduction of orthodontic treatment time represents one of the more common requests by patients. However, while we attend to the patient’s request, safely moving teeth and stability of our results are very important and must be stressed. The acceleration of dental movement and treatment time also may help in reducing the risk of caries resulting from difficulties in maintaining adequate hygiene, in reducing the effort on the part of the patient and in allowing the orthodontist to obtain complex orthodontic movement using simple biomechanics. Especially from a biological point of view, there is a reduction of stress on the dental roots and on the supporting surface and deep tissue.1

In medical literature, various non-surgical approaches have been reported to achieve the acceleration of orthodontic movement, for instance laser biostimulation and photo-biomodulation,2 the application of magnetic fields,3 as well as the targeted injection of prostaglandin E24 and vitamin D.5 The surgical approach is instead represented by the dentoalveolar corticotomy procedure 6 in which the acceleration of dental movement is achieved owing to an induced state of transient osteopenia, defined by Frost as the “Regional Acceleratory Process”,7 which results immediately from surgical wounding of the bone caused by the corticotomy procedure. Other surgical techniques used to induce transient osteopenia (accelerated osteogenic orthodontics,8 periodontally accelerated osteogenic orthodontics,9 corticision,10 piezocision11 and micro-osteoperforations12) may be considered as variations in invasive approaches, but are nonetheless based on the induction of cortical lesions.

More recently, devices (AcceleDent Optima, OrthoAccel Technologies) have been described that can accelerate tooth movement through the transmission of cyclic vibratory forces or cyclic loading of 0.25 N (25 g) at low frequency (30 Hz). Such a device includes a mouthpiece and is to be used by the patient for 20 minutes per day.

In a randomised clinical trial, Pavlin et al. found that the application of vibrations by means of the AcceleDent Optima device associated with fixed orthodontic treatment considerably increased the rate of dental movement.13 In fact, the rate of tooth movement per month in the group of patients who used AcceleDent (1.16 mm/month) was 48.1% faster than in the control group (0.79 mm/month). A retrospective study by Bowman showed that the alignment and levelling time of the lower jaw was faster in the group using AcceleDent (93 days) than in the control group (120 days).14 This is equivalent to a 30% reduction in treatment time. A study by Orton-Gibbs and Kim found that fixed orthodontic treatment in combination with AcceleDent was 38.2% faster and aligner treatment in combination with AcceleDent was 37.2% faster.15

The purpose of this report is to present a case of a patient with severe crowding. Treatment included interradicular corticotomies in conjunction with the AcceleDent device.

Case report

The 17-year-old male patient came for an examination in December 2014. The objective intra-oral examination revealed a bilateral Class I molar relationship and a canine relation of Class I and Class II on the right. The transverse trans-molar diameter of the upper dental arch was normal, while there was a reduction in the inter-premolar diameter associated with severe crowding in the inter-canine region. In the lower dental arch (narrow, parabolic shape), there was dental crowding with complete deficiency for tooth #42, which was in an ectopic lingual position. Complete deep bite with masticatory trauma to the adjacent gingiva was observed in the lower incisal region. The teeth of the upper arch were slightly larger than average, with a minor moderation of Bolton’s index.

The cephalometric analysis confirmed a Class I skeletal pattern (ANB angle: 4°), meso-divergent facial pattern (SN–GoGn angle: 35°) with retroclination of the mandib-
ular incisor (incisor mandibular plane angle [IMPA]: 84°) and proclination of the maxillary incisor (U1–SN angle: 117°; Figs. 10a & 11a).

The following treatment options based upon treatment goals were considered:
1. If facial balance and airway extension were paramount to the patient, orthognathic surgery would be the plan of choice.
2. If tooth alignment was the only goal, an orthodontic plan in conjunction with corticotomies and AcceleDent would be followed.

The case could also have had a maxillofacial surgical resolution after extracting two premolars in the lower arch and closing the spaces to allow greater mandibular advancement. The patient was not ready to accept this treatment method. The decision was, therefore, taken to proceed without extractions with the help of the interradicular corticotomies in the upper arch and the use of the AcceleDent device for the alignment of the lower arch.

Surgery was performed under local anaesthesia on the upper dental arch with the incision and detachment of a full-thickness flap from tooth #16 to 26. After performing interradicular corticotomies, an antigen-free porcine bone graft was applied and covered with a platelet-rich fibrin membrane (Figs. 2a & b).16 The flap was repositioned with detached sutures.

Seven days after surgery, the suture was removed and a quadhelix appliance was applied with the aim of molar de-rotation and rapid palatal expansion. At the same time, the upper arch was bonded with self-ligating brackets (Damon Q; Figs. 3a–d). Alignment and levelling of the upper arch were achieved using nickel-titanium archwires in the following sequence: 0.014, 0.018, 0.016 × 0.022, 0.019 × 0.025 in.

Six months after the intervention, a mandibular bi-helix expander was cemented with the aim of transverse expansion of the posterior and mandibular sections (Fig. 4). At the same time, the AcceleDent device was delivered and the patient was advised to use it for 20 minutes per day. Two months later, following uprighting of the posterior and mandibular sections, the lower arch was bonded with self-ligating brackets (Damon Q), with the exception of tooth #42. Alignment and levelling of the lower arch were
achieved using nickel-titanium archwires in the following sequence: 0.014, 0.016, 0.018, 0.019 × 0.025 in. The space required for tooth #42 in the ectopic lingual position was obtained within eight months after the lower bi-helix application and six months after the bonding of the lower arch. The space was reached by inserting from the first archwire an open spring coil between teeth #41 and 43 and retrieving it in the arch by initially introducing a ligature for closure and subsequently, upon attaining the correct fit, bonding and engaging tooth #42 with a 0.016 in. nickel-titanium archwire (Figs. 5a–e). After the alignment and levelling of the mandibular right lateral incisor, the final treatment step involved the correction of the Class II left canine using Class II intermaxillary elastic bands with 0.019 × 0.022 in. stainless-steel upper and lower archwires.

The objectives of the treatment plan were achieved in 21 months by attaining a Class I molar and canine relationship with ideal overjet and overbite. A fixed mandibular retainer and a maxillary Hawley retainer (Figs. 6a–h) were used for retention.

Discussion

After collecting and analysing the records, it became clear that the case was particularly complex because, while the lack of space in the upper arch did not require extraction, the lack of space in the lower arch would require extraction, which would prevent the patient from achieving an ideal overjet and overbite. Obviously, the complexity of the case could give rise to different and varied treatment interpretations, such as extraction of two premolars and closure of spaces and subsequent mandibular advancement, increase of the inter-canine diameter through the transmandibular distraction surgical treatment method, extraction of tooth #42 and the final phase of the case without a centred midline with overjet and increased overbite. The initial retroclined position (IMPA: 87°) and the presence of a well-represented symphysis allowed satisfactory vestibularisation of the incisors (IMPA: 104°) with an excellent response of the soft tissue (Fig. 7) and bone (Figs. 10b & 11b). At the level of the upper arch, the CBCT scan revealed an improvement
in bone tropism in the premolar area due to the bone graft inserted during the corticotomy procedure (Figs. 8a-8f & 9a-9d). The decision to treat the lower arch without a corticotomy procedure and with only the vibration forces induced by cyclic loading was due to the fact that the patient did not want to undergo a second surgery, which would have been complicated given the ectopic position of tooth #42 and on the basis of confirmed cases in the medical literature\textsuperscript{15} about faster alignment and levelling of the lower arch in patients treated with AcceleDent.

**Conclusion**

This case report has demonstrated the use and effectiveness of AcceleDent in a challenging environment (crowding, little bone and narrow arches). Future work by the authors and others can pool data to demonstrate the effectiveness of non-invasive accelerated technology to provide patients with not only accelerated tooth movement, but more importantly predictable tooth movement where teeth can be moved safely.

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