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Case Report

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The biology of orthodontic treatment time; days versus years

Abstract

The accurate assessment of the treatment time of an orthodontic case and its actual duration are extremely important considerations for patient acceptance of treatment as well as the credibility of the health care provider and the financial health of the dental practice. There are multiple variables that can affect orthodontic treatment time ranging from diagnosis, to treatment protocols and patient compliance. While these variables have been widely studied there is a lack of innovation in orthodontic bracket design and its potential impact on decreasing orthodontic treatment times. Three orthodontic patients, seen by three different clinicians present to individual offices with a pre-treatment Angle classification of Class I, Class II and Class III respectively and are successfully treated in markedly reduced orthodontic treatment times with the new patented bracket system of FASTBRACES® Technologies known as FASTBRACES® TURBO™. The patented systems of FASTBRACES® Technologies facilitate the continuation of eruption while possibly inducing alveolar bone remodeling and development in short treatment times by moving the tooth roots toward their final naturally erupted position from the beginning of treatment. This orthodontically induced eruption of teeth results in the successful completion of cases non-extraction in markedly reduced treatment times.

Keywords: orthoeruption, orthodontics, braces, alveolar bone growth, orthodontic treatment time

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Introduction

Invariably every potential orthodontic patient in the consultation or treatment planning phase is eager to know the proposed total duration of treatment. Motivation with compliance and commitment to treatment are important factors for the patient and the family along with associated financial implications. The clinician must be prepared to provide therapy that meets the specific lifestyle needs of patients, especially with an increasing segment of the adult population now seeking orthodontic care.[1] Treatment efficiency translates directly into practice financial health for the clinician because unanticipated prolonged treatment time erodes profitability. Cost efficiencies become even more important as the size of a practice grows and are an area of interest for a third party (insurance) provider.[2] A system that accurately predicts orthodontic treatment time is key to both the clinician and patient because it provides a vitally important tool in practice building[2] for the clinician and is directly related to greater overall patient satisfaction.[3] Furthermore, a system of braces that safely, predictably and effectively treats a broad cross section of clinical presentations non-extraction, while substantially reducing orthodontic treatment time presents an extremely desirable therapy for both clinician and patient.

While a review of the key factors and variables that affect orthodontic treatment time is important, this paper will also review a new biologically-based paradigm in orthodontic diagnosis[4] and a novel biologically based orthodontic treatment approach. In addition, the authors will provide three cases of Angle's orthodontic classifications of Class I, II and III, all treated with the patented systems of FASTBRACES® Technologies. This revolutionary design known as FASTBRACES® TURBO™ illustrates the potential to safely stimulate alveolar bone growth in even shorter treatment times based on the non-extraction mechanically and possibly organically induced continuation of eruption by moving the roots towards their final position from the onset of therapy. Orthodontic treatment times can now be classified in terms of days rather than years. There is a substantial body of literature that has studied variables which could influence treatment times in both adolescents and adults. It has been suggested that the key distinguishing factors between adult and adolescent patients are lack of active growth, periodontal involvement and a higher occurrence of restorative interventions.[5] These traditional variables which can affect orthodontic treatment time can generally be grouped into diagnosis (including demographic observations), treatment, and degree of patient compliance.

Diagnostic variables

Among this group which excludes craniofacial abnormalities, generally accepted parameters include gender,[5–9] age,[10] pre-treatment molar relationship, general pre-treatment assessment of malocclusion[11] including overjet[12,13] and overbite[14,15] along with a variety of cephalometric features (i.e. SNA, SNB and ANB).[13,15]

Treatment protocols

A generally accepted subset of this category includes extraction or non-extraction therapy,[5–16] technique or operator skill and experience,[9–17] the comparison of ceramic vs. metal brackets[6] along with issues of orthodontic appliance breakage.[6,11]

Patient compliance

This category includes oral hygiene during active treatment,[11–19] the number of missed appointments[11] and even compliance with use

of intraoral elastics.[11–20] Taken together the majority of studies show conflicting results particularly when examining certain variables in the Diagnosis and Treatment categories. Specifically, there appears to be disagreement or lack of consensus on whether treatment time is affected when examining both pre-treatment malocclusion[5–8] and molar relationships.[5–11] Interestingly enough the majority of studies indicate that extraction therapy may increase treatment time when compared to non-extraction therapy.[5–11] Factors such as gender, the choice of ceramic vs. metal brackets and facial pattern had no significant influence on orthodontic treatment time particularly for the adult. What seems to be consistent as it relates to affecting and lengthening treatment time is in the Patient Compliance category and includes the above referenced factors of oral hygiene, the number of missed appointments, compliance with use of intraoral elastics and incidence of broken appliances?

Report of cases

Three adult patients, seen by three different providers presented for orthodontic treatment with Angle classifications of Class I, Class II and Class III respectively. Full maxillary and mandibular fixed appliances followed by retainers were applied for all three cases. Treatment time for the three patients presenting with Class I, Class II and Class III malocclusions took 96 days, 72 days and 117 days respectively (Figures 1−3).

Figure 1 Before, during, and after frontal Photographs of angle class I malocclusion treated in 96 days (*Courtesy of Dr. Patrick Assal, Lausanne, Switzerland*).

Figure 2 Before, during, and after frontal photographs of Angle class II malocclusion treated in 72 days (*Courtesy of Dr. Melissa Goddard, Liverpool, United Kingdom*).

Figure 3 Before, during, and after frontal photographs ofAngle class III malocclusion treated in 117 days (*Courtesy of Dr. Stephan Van Vuuren, London, United Kingdom*).

Discussion

The extraordinary reductions of treatment times for Class I, II and III cases are clearly demonstrated in these three case reports. The question the clinicians should be asking is how orthodontic treatment times now can be addressed in terms of days when nearly all comprehensive orthodontic case treatment times are addressed in terms of years. While esthetic and functional concerns represent the key elements for patients seeking orthodontic treatment, the proposed treatment time in many cases represents the central cohesive element of a patient accepting a proposed orthodontic treatment plan. In addition, it is incumbent upon the clinician to assimilate possible individual patient variables that could potentially affect treatment time and present both the most accurate and if possible, the shortest orthodontic time with great attention to safety, patient comfort, and clinical efficacy. While a wide range of variables potentially affecting orthodontic treatment time are widely cited in the literature there is great controversy surrounding the scientific basis of outdated yet remarkably enduring diagnostic terminology - particularly Angle's classification which dates back to 1899.[21] This is coupled with a substantial gap in knowledge and understanding of biologically based orthodontic diagnostic terms, the clinical recommendation of extraction therapy that is largely based upon outdated concepts which maintain that alveolar bone has little or no capacity to grow[22] and the lack of innovation in bracket design. Even with the introduction of flexible nickel-titanium orthodontic wires, clinicians have not evolved from a segmented approach to therapy that fundamentally contemplates the use of a rounds wire to move clinical crowns at the beginning of treatment which is followed by the addition of successive rectangular wires to move the roots of teeth. In aggregate, the combination of diagnostic terms that lack scientific validity, stagnation in bracket innovation and a seemingly unwavering adherence to the static nature of alveolar bone drives the clinician to extraction therapy or non-extraction from uncontrolled tipping of teeth with round wires. The use of outdated orthodontic mechanics clinically delivers excessive orthodontic mechanical forces with a staged multiple wire approach of moving crowns then roots through, rather than with alveolar bone. The cumulative effect is a greater duration of treatment with increased mechanical forces. Therefore, it is the opinion of the authors that these practices represent some of the most important reasons why orthodontic treatment times have not been decreased. It is ironic that many diagnostic, treatment and patient compliance variables have been studied without contemplating the impact of improving bracket design and biomechanics. One need not look further than the lighter force, the capacity to stimulate remodeling and growth of alveolar bone along with the associated treatment time of natural eruption in order to develop advanced orthodontic technology systems. These new patented systems of braces known as FASTBRACES® Technologies are designed to facilitate the continuation of eruption while inducing alveolar bone remodeling and development in short treatment times by moving the tooth roots toward their final naturally erupted position from the beginning of treatment. This orthodontically induced eruption of teeth results in the successful completion of cases non-extraction.

Viazis et al.[4] introduced the biologically based orthodontic diagnostic terms of Orthodontosis and Orthodontitis.[4] Orthodontosis is defined as the non-inflammatory deficiency of alveolar bone in the horizontal dimension caused by the displaced root(s) of the tooth, typically palatally or lingually. Orthodontitis is defined as associated excess soft tissue manifestation and chronic inflammation. In effect the hard tissue bony hypoplasia (Orthodontosis) and soft tissue manifestation (Orthodontitis) associated with malpositioned roots represent unfinished eruption. Based upon these definitions, orthodontic treatment should be directed towards mimicking and continuing the light forces of natural eruption possibly stimulating bone remodeling around displaced roots thereby eliminating the need for extraction therapy. Furthermore, this mechanically assisted continuation of eruption has been defined as Orthoeruption in the literature[4] and allows for the up-righting of displaced roots into a straight position as if the teeth erupted in that position. Therefore, Orthoeruption results in the alveolar bone remodeling and restoration of the dental arch to its appropriate natural size and shape. Accordingly,

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non-extraction therapy is almost always achieved through this alveolar bone growth as the alveolar bone reacts to a tooth erupting in its correct place in the arch.

The three cases presented in this paper along with other published literature[23–37] illustrate the potential to stimulate remodeling and growth of alveolar bone with the patented orthodontic systems of FASTBRACES® Technologies almost irrespective of the type of pre-treatment dental malocclusion. The authors believe these new technology systems of braces including the newly introduced FASTBRACES® TURBO™ facilitate the continuation of eruption while inducing alveolar bone remodeling and development in short treatment times by moving the tooth roots toward their final naturally erupted position from the beginning of treatment design. Theoretically and when compared to natural continuous eruption, the technology sustains Orthoeruption which induces alveolar bone formation thereby providing space. This self-generating process of alveolar bone could closely mimic natural eruption by organically induced alveolar bone growth and remodeling. This orthodontically induced eruption of teeth results in the successful completion of cases non-extraction. Our theory requires additional study both at the clinical and biological level. For example, while the authors believe that Orthoeruption is said to be similar to or the continuation of natural eruption we realize that natural eruption takes place with a developing root and an incompletely formed periodontal ligament while Orthoeruption takes place with a fully formed root and periodontal ligament. Why then are there reduced treatment times with the patented systems of FASTBRACES® Technologies and how can a fully formed root continue to erupt or exhibit Orthoeruption with reduced treatment times which approximates the time frame of natural continuous eruption? All cases presented herein finished within 120 days which is typically the time frame of the continuous eruption of teeth or from the moment the clinical crown appears in the oral cavity until it reaches occlusal contact with the dentition of the opposing arch. It thus begs the question that Orthoeruption by continuing the motion of the tooth by utilizing the light forces of the patented systems of FASTBRACES® Technologies happens within the normal biological boundaries of the human body. Further speculation may lead the clinician to surmise that the patient "feel" of normality similar to that of natural eruption (with the exception of an exfoliating deciduous tooth for example) represents the ideal force that fools the body by continuing the eruption during treatment.

One area to explore is hyalinization of the periodontal ligament (PDL) during orthodontic tooth movement. Hyalinization fundamentally represents the localized degenerative change in the ultrastructure of the periodontal ligament brought on by pressure during orthodontic tooth movement. This is based on the well-established pressure/tension theory of orthodontic tooth movement which even recent literature suggests that as a theory it is not completely understood.[28] Specifically, this localized cell death or hyalinization on the pressure side of orthodontic tooth movement against the periodontal ligament is an undesirable effect characterized by disturbances in blood flow and changes in the PDL collagenous matrix caused by the tipping forces of round wires that concentrate around the cemeto-enamel-junction and the root apex. In the presence of hyalinization, orthodontic tooth movement cannot occur until the hyalinized tissue is resorbed and replaced by healthy tissue again. This then allows the underlining resorption of adjacent alveolar bone which represents tooth movement. The hallmark clinical presentation of hyalinization is periodontal pain which is caused by the combination of inflammation, edema, pressure and ischemia. Pain typically starts within 4 hours of traditional orthodontic activation increasing over the next 24 hours. Inflammation on the other hand subsides in about six weeks and tissues are restored accordingly. Therefore, traditional orthodontic treatment initiates excessive and unevenly distributed mechanical forces which then create hyalinization of the PDL thereby stopping active tooth movement while generating patient pain.[29] The limiting factor in decreasing orthodontic treatment time appears to be hyalinization induced by the clinician. The PDL may be restored but the root apex is permanently resorbed–accepting it as a consequence of traditional orthodontic tooth movement. This unfavorable sequence of biological events causes a significant treatment time gap until tissues are restored from hyalinization only to have them damaged again with a subsequent orthodontic treatment visit. This creates a cycle of inefficient and prolonged treatment, patient discomfort and possible root resorption.

As shown in other published literature,[23–29] orthodontic therapy with the patented systems of FASTBRACES® Technologies can safely, effectively and efficiently complete treatment non-extraction with little patient discomfort, and with little to no apical resorption all among a diverse set of clinical presentations. Therefore, the orthodontic or tooth movement process, the lack of root damage, the lack of patient pain and a completion time of 120 days approximates natural eruption. This lack of patient pain coupled with a duration of treatment equivalent to natural continuous eruption and a natural looking mouth upon treatment completion strongly suggests a new paradigm of orthodontic tooth movement that is biologically based and similar to natural continuous eruption. Furthermore, the absence of pain in both natural eruption and Orthoeruption strongly suggests little to no inflammation or little to no hyalinization. The authors believe that shortened treatment times with the patented systems of FASTBRACES® Technologies are strongly correlated with semi-hyalinization to no hyalinization. Additional research is needed to study possible shortened times of hyalinization or even unremarkable changes towards hyalinization with the lighter forces of the patented systems of FASTBRACES® Technologies as a possible reason for markedly decreased orthodontic treatment time. Another area of research that may provide additional clues of the underlining biology of decreasing orthodontic treatment times would be to compare the complex interactions and cascade of reactions between alveolar bone remodeling associated with orthodontic tooth movement and the biology of fracture healing whether alveolar or other. This might suggest a way to minimize the impact of our orthodontic interventions so as to facilitate and promote alveolar bone remodeling and growth thereby decreasing orthodontic treatment time.

Conclusion

The three case reports covered in this paper illustrate the potential to stimulate remodeling and growth of alveolar bone with shortened treatment times by utilizing the patented orthodontic systems of FASTBRACES® Technologies which is based on the non-extraction mechanically aided continuation of eruption by moving the roots toward their final position from the onset of therapy. The shortened orthodontic treatment times are consistent across a diverse cross section of pre-treatment malocclusions with treatment performed by three different clinicians. The authors suggest that among variables used to access duration of orthodontic treatment there is a considerable gap of knowledge in biologically based orthodontic diagnosis, associated treatment planning and most importantly,

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a lack of innovation in bracket design. The introduction of the patented systems of FASTBRACES® Technologies including the newly introduced FASTBRACES® TURBO™ represent novel and innovative systems which facilitate what the authors believe to be the continuation of natural eruption or Orthoeruption inducing alveolar bone remodeling and development by moving the tooth roots toward their final naturally erupted position from the beginning of treatment. This orthodontically induced eruption of teeth results in the successful completion of cases non-extraction. Similarities between the processes of natural continuous eruption and Orthoeruption suggest a lack of inflammation and therefore a diminished degree of or absence of hyalinization as the possible key to reduced orthodontic treatment times with the patented systems of FASTBRACES® Technologies.

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Conflicts of interest

Author declares that there are no conflicts of interest.

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