One of the most important goals in health care is to deliver effective and efficient therapies. Effectiveness of treatment involves achieving the desired result, while efficiency accounts for the time and resources required to obtain the expected outcome. Efficiency of treatment has become one of the major aims in health care. The National Institute of Health (NIH) has taken keen interest in this type of research as potential health-care costs may be reduced. In orthodontics some interest has also surged in this area. An example is the randomized clinical trials evaluating two phases vs. one phase treatment in Class II malocclusions.

The feasibility of moving teeth faster is another area of interest related to efficiency that is emerging in orthodontics. This would have the potential advantage of reducing treatment times, with the inherent benefit of eliminating or reducing the negative sequelae often associated with extended treatment times i.e., root resorption, periodontal problems, and white spot lesions. In addition, modern society might also have keen interest in shorter treatment times as the notion of instant gratification might be a new expectation, especially when treatment is associated with aesthetic procedures.

The possibilities of attaining faster orthodontic tooth movement are closely tied to the word biomechanics. Hence, the biology could be altered or the mechanics adjusted. Certainly, a combination of both is also possible. When the biology is considered, interesting results have been produced in basic science research using animal models. Different molecules have been proven to be efficient in targeting the osteoclast, which in turn is responsible for resorbing the bone in order to ensure faster orthodontic tooth movement. However, as King summarized, “We are still far from the option of clinically delivering biological substances to enhance orthodontic treatment. These substances have to be proven safe, localized and self-limiting in action.”

The other aspect that can be targeted is the mechanical component. In this area some clinicians have claimed that the use of “frictionless appliances” might provide efficiency in treatment. This claim remains unsubstantiated as the majority of clinical research in this area has failed to show this efficiency.
Furthermore, it could be difficult to explain how an appliance with less friction translates biologically into faster orthodontic tooth movement. Overall, the more pertinent question that remains to be answered is the magnitude of the optimal force needed to achieve the highest efficiency.

The consensus has been that a low continuous force could be the most physiologic way to move teeth. However, it is still not clear what a low force or a high force really mean. A systematic review showed that the magnitude of an optimal force (most effective) is unknown. Some experimental approaches that have been attempted in relation to force delivery are intermittent vs. continuous forces and the application of higher initial forces followed by forces of lesser magnitude. It seems that a continuous force could be most effective; however, optimal force magnitudes might vary between types of tooth movements and individuals.

The third option to attain faster tooth movement targets both the biology and the mechanics. The biology is modulated through a mechanical or physical alteration of the bone, and an applied orthodontic force is superposed. Surgical procedures such as corticotomies and osteotomies, vibration, and low energy lasers belong to this category. The two latter ones have been applied recently, mostly in basic science models. The results have been positive, reporting efficiency in orthodontic tooth movement. On the other hand, the two localized surgical procedures have been approached clinically for many years, and only until recently they have been gaining increased attention.

**Corticotomies**

A corticotomy is the procedure by which a flap is elevated and the cortical bone is scored with a bur or piezosurgical instrument approximately 1-2 mm in depth. This method was described more than five decades ago and used in conjunction with orthodontic appliances in order to facilitate orthodontic tooth movement. The original description consisted of interproximal grooves between adjacent teeth with a sub-apical corticotomy. The technique was modified by Wilcko, et. al., who added a particulate bone allograft over the alveolar decorticated surfaces. The technique was labeled accelerated osteogenic orthodontics (AOO). The benefits claimed were increased alveolar bone width, which allowed to labially displace the teeth, better stability, and increased efficiency in orthodontic tooth movement.

**Animal Studies**

The increased efficiency in tooth movement has been related to a series of biological effects that are precipitated by the surgical cuts. This phenomenon has been described as a regional accelerated phenomenon (RAP) that might increase the bone turnover, thus facilitating the expedited tooth movement. Animal studies using this technique have shown contradictory results. A study by Lee compared the speed in tooth movement in rats between corticotomy-assisted orthodontics, osteotomy-assisted orthodontics, and orthodontics alone. They found no significant difference between groups in a three-week period. Two more studies, one in dogs and another in foxhounds also found increased rates of tooth movement.

The surgical technique of the corticotomies has evolved to become less extensive. It has been proposed that limiting the corticotomy to circumscribed indentations of the cortical bone might suffice to establish a biological response necessary for increased bone turnover, thus enhanced tooth movement. It has been proposed that the flap procedure might be omitted and small interproximal vertical incisions performed with a reinforced scalpel on the labial and lingual mucosa might be sufficient to trigger accelerated tooth movement. An animal study in cats showed expedited tooth movement with this procedure named corticision. A similar clinical application of this method was published recently, where a small interproximal vertical incision was performed on the buccal aspect of the gingiva on both the maxillary and mandibular arch. In addition, a piezotome was used to score the cortical bone through the gingival incisions. Bone graft material was packed in the anterior region where the alveolar bone width was considered to be narrow. The authors named the technique piezoincision and documented a case report of an adult patient with mild crowding whose malocclusion was corrected in a very short period of time.

**Clinical Applications of Corticotomies**

Several applications have been published using corticotomies as an adjunct to orthodontic treatment. The most common description has been for the treatment of crowding. However, it has been also described for the intrusion of molars, treatment of bimaxillary protrusion, molar distalization and canine impactions. This technique is being explored currently at the University of Connecticut for molar protraction in patients with congenitally missing second premolars, or first molars lost to caries. The technique is being combined with skeletal anchorage to evaluate if the time to achieve a significant amount of molar protraction might be reduced. Overall, it is important to highlight that the treatment times seem to be reduced with corticotomies in all clinical applications. However, a word of caution is needed as the majority of evidence available is based on few case reports of the technique.

**Osteotomies**

Another surgical intervention that has been explored clinically is the complete segmentation of a tooth or group of teeth through the cortical and medullary bone. This technique relies

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in the application of heavy orthopedic forces after the segmentation. The force magnitude applied is in the range of 800 grams, or higher orthopedic forces delivered with osseous distraction devices. This approach has been applied mostly in the expedited treatment of patients with bimaxillary protrusion undergoing four premolar extractions.

Two basic techniques have been described for the space closure in these patients undergoing four premolar extractions. In one approach, the canine is distracted distally in a one to two week period, and then the incisors are moved lingually through traditional orthodontic forces. A second approach is the osteotomy of the whole anterior canine to canine segment in the maxilla, and the application of a heavy orthodontic retraction force. This is done in combination with a lower subapical segmental osteotomy of the canine-to-canine segment of the mandible which is immediately set back into position.

Treatment times for these patients have reported to be approximately 10 months. Another application for osteotomies has been explored in the treatment of ankylosed central incisors. This has been accomplished through interproximal segmentation of the bone fragment containing the central incisor, and the application of a distraction device or a heavy orthodontic force. Recently, at the University of Connecticut, this technique was successfully applied to an ankylosed canine. The procedure was made through a careful approach using piezosurgery to prevent injury to the canine and adjacent roots. The bony impacted canine was brought into the arch in three weeks with a heavy orthodontic force. Although this is a promising option for ankylosed canines, it is limited to those that are positioned in such location where surgical access is possible without a significant risk of affecting the surrounding teeth and anatomic structures.
Figures 3a - 3g: Extra and intraoral photos one month after surgery.

Figures 4a - 4e: Intraoral photos three months after surgery.

Figure 5a - 5j: Extra and intraoral photos and X-rays at the end of treatment. Total treatment time six months and 27 days.

Figure 2: Surgical prediction.

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Surgery First

A final permutation of the osteotomies technique is related to the concept of surgery first. This concept was introduced in the early 90s with the idea of eliminating the presurgical orthodontic phase in patients undergoing orthognathic surgery. Recently, Nagasaka reintroduced the concept and applied it to a Class III patient where the presurgical phase was omitted. A case report described this technique, which was facilitated by skeletal anchorage. The skeletal anchorage provided by four plates placed at the time of surgery, offered the biomechanical advantage to obtain significant orthodontic movements in the postsurgical phase. The total treatment time for this patient was only one year, albeit including significant maxillary distalization.

This significantly contrasts with the recent prospective study of orthognathic surgery of patients in the United Kingdom where the average treatment time was 32 months, including a presurgical phase of 12-18 months. The advantages of the surgery first technique were an immediate correction of the skeletal deformity, the elimination of the soft tissue imbalance, which might facilitate the orthodontic movements, and the expedited treatment time. They postulated that this reduced treatment time might be related to the RAP phenomenon triggered by the surgical osteotomies.

Recently, at the University of Connecticut and at the Instituto de Ciencias de la Salud the surgery first technique has been simplified. Instead of placing a passive wire at the time of surgery, a NiTi aligning wire is placed in both arches just before the surgical procedure. By doing so, it eliminated the complicated task of bending a passive rectangular stainless steel wire to a malaligned arch. In addition, the window of the RAP might be maximized as the tooth movement is occurring immediately after surgery. The technique has been applied primarily to the treatment of Class III malocclusions with significant reduction in treatment times (Figures 1-5). This technique appears to be promising as patients are greatly satisfied with the short treatment times and the immediate “makeover,” without the accentuation of the deformity often observed after the presurgical decompression phase.

Conclusion

A great interest has sparked in the profession in expediting tooth movement. Although biological intervention with different molecules will most likely occur in the future, at the current time only surgical procedures have shown some promise in enhancing the speed of tooth movement. Some of these procedures are corticotomies and osteotomies in conjunction to traditional orthodontic appliances. Finally, the surgery first concept might become mainstream in orthognathic surgery as significant reduction in treatment times and immediate patient gratification are tempting advantages of the technique.

References

Author’s Bio

Dr. Flavio Uribe received his Master’s degree and Certificate in Orthodontics from the University of Connecticut after receiving the DDS degree from CES University in Medellin, Colombia. He also completed a three-year residency and fellowship in General Dentistry at the University of Connecticut. Dr. Uribe is a full-time associate professor and program director in the Division of Orthodontics at the University of Connecticut and has authored and coauthored numerous chapters and articles in peer-reviewed journals.

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