Selective alveolar corticotomy to intrude overerupted molars

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Orthodontic intrusion of overerupted molars in adults is challenging for most clinicians. Efficient intrusion can be achieved by combining selective alveolar corticotomies with a modified full-coverage maxillary splint to reduce surgical risks, treatment time, and costs for both orthodontists and patients. (Am J Orthod Dentofacial Orthop 2008;133:902-8)

Orthodontic treatment of overerupted molars has always been considered challenging for most orthodontists. Pure intrusion can only be achieved when an adequate anchorage system supports light and continuous forces that are directed through the tooth’s center of resistance.1,2 This approach is particularly difficult when posterior teeth must be intruded in adults. The lack of compensation through growth3 and the slower biologic response to orthodontic forces, when compared to younger patients,4,5 increase the complexity of this procedure. More adults now seek orthodontic care. Consequently, clinicians might see patients who need molar intrusion more often.

The correction of supraerupted molars with conventional fixed appliances can lead to undesirable extrusion of the adjacent teeth that function as anchor units, lengthening the overall treatment time and compromising the results.6 Various approaches have been proposed to intrude overerupted molars, including vertical-pull headgears,7 removable appliances with elastics,8 modified palatal arches,9 elastomeric chains,10 magnets,11 and skeletal anchorage systems.12,13 The need for patient cooperation for long time periods and the difficulties in applying well-controlled force systems have been suggested as limitations of these early methods of molar intrusion.14 Although the use of mini-titanium screws solved most anchorage problems when intrusion of posterior teeth is required, individual anatomical variations might impose limitations for adequate implant placement in some patients.15 Unsatisfactory implant positioning can result in undesired sequelae, such as root perforations,16 or lead to inappropriate direction of intrusive forces, compromising treatment efficiency.

Tooth movement efficiency can be increased when well-planned force systems are applied to bony tissues that offer less resistance against the desired movement.1,17 Therefore, faster orthodontic movement takes place, and treatment goals can be achieved in a shorter time, without compromising the results. Since treatment efficiency is always a concern in adult orthodontics, how can it be achieved when molar intrusion is needed? Overall, orthodontic tooth movement is accelerated when performed under increased bone turnover conditions18 caused by either pharmacologic modulation19,20 or hormonal alterations.21,22 However, these possibilities have not yet reached routine application in the daily orthodontic practice. The physiologic alterations observed when the bony tissues respond to a traumatic stimulus might help to elucidate an alternative approach that could create a localized area of increased bone turnover and, consequently, decreased resistance to tooth movement.

When responding to a traumatic stimulus, the bony tissues initially have a biologic stage called regional acceleratory phenomenon characterized by a transient increase in bone turnover and a decrease in trabecular bone density.23 After fractures or surgical osteotomies, the regional acceleratory phenomenon significantly stimulates healing and tissue reorganization by a temporary burst of localized tissue remodeling.24 Alveolar corticotomies are surgical interventions limited to cortical bone that were suggested as an alternative to facilitate the treatment of complex occlusal problems.
combined with orthodontic therapy. Although no studies have directly investigated whether corticotomies result in alveolar bone regional acceleratory phenomena or how they influence tooth movement, clinical reports have shown that orthodontic movement was potentiated when started shortly after selective alveolar corticotomies.

The initial reports on combining orthodontic therapy and alveolar corticotomies suggested that treatment was facilitated because the bone blocks limited by the surgical cuts could be moved individually by using the crowns of the teeth as handles to which orthodontic forces were applied. Wilcko et al questioned these statements, implying that the healing stimulus generated by the corticotomy leads to increased bone turnover and a less dense trabecular bone. The authors suggested that decreased trabecular bone density and not movement of independent bone blocks would better explain the effects of alveolar corticotomies on orthodontic therapy. Despite these opposing points of view, all clinical reports showed increased treatment efficiency. This article describes the combination of selective alveolar corticotomies and a modified full-coverage maxillary splint to efficiently intrude overerupted molars in adult patients.

**Surgical procedure**

The surgeries were performed with the patients under local anesthesia. Full-thickness flaps were raised on both buccal and lingual surfaces to expose the alveolus surrounding the overerupted maxillary first molars. Cortical bone was removed by using a #701 surgical bur under continuous and abundant irrigation with cold sterile saline solution. Vertical cuts were made on both mesial and distal interproximal areas starting 2 to 3 mm above the alveolar crest and extending 2 to 3 mm past the estimated root apices. A horizontal corticotomy was performed connecting the interdental cuts. Several small round perforations equivalent to the bur diameter were also made inside the areas circumscribed by those cuts to increase the healing stimulus. All surgical cuts were made in the cortical plate, barely penetrating the trabecular bone. After careful irrigation, the gingival flaps were repositioned and sutured appropriately. Antibiotics and anti-inflammatories were prescribed from 24 hours before to 3 days postsurgery.

**Intrusion appliance design**

Maxillary and mandibular alginate impressions were taken, and the working models obtained with stone were mounted in a hinge axis articulator. A full-coverage flat-plane maxillary splint was fabricated with acrylic. Ball clasps were added between the first premolars and the canines to increase appliance retention, and small J-hooks were placed on both buccal and lingual surfaces of the first molars. The acrylic covering the maxillary first molars’ occlusal surfaces was removed to allow intrusion force delivery. Closed Sentralloy coils (GAC International, Islandia, NY) were tied to the J-hooks with steel ligatures to allow constant 100-g intrusive forces apically through the center of resistance of the molars.

**PATIENT 1**

A 36-year-old woman was referred to the Department of Orthodontics of the Pontifical Catholic University of Minas Gerais in Brazil for an evaluation about the chances of intruding overerupted maxillary right and left first molars. The patient reported losing all mandibular first and second permanent molars in early adolescence. These teeth had never been replaced, resulting in overeruption of both maxillary first molars. Three treatment options to level her maxillary occlusal plane were presented: (1) restorative leveling with full crowns and possible need for root canal treatment, as well as periodontal surgery to obtain appropriate cemento-enamel junction dimensions; (2) subapical osteotomies for immediate bone-block intrusion; and (3) selective alveolar corticotomies followed by orthodontic treatment to intrude the maxillary first molars. The patient was informed of the risks, advantages, and disadvantages of all therapeutic approaches. She decided to undergo orthodontic treatment after corticotomies and signed a consent form assuming all responsibilities for her decision.

Seven days after surgery, orthodontic forces were applied with the modified maxillary splint previously described. The patient reported mild postcorticotomy discomfort, describing it as similar to the soreness she felt after previous tooth extractions.
recommendations for full-time appliance wear, except during meals and oral-hygiene procedures. Two and a half months after the force application, the maxillary first molars were fully intruded (Fig 3, B). At this point, fixed appliances were placed to continue treatment, and, 3 months later, progress records were obtained for reevaluation (Fig 3, C). Cephalometric superimposition before treatment and 6 months into treatment showed complete and pure intrusion of the overerupted molars (Fig 4, A), without commonly seen side effects, such as clockwise rotation of the mandible and anterior bite opening. Comparison of the periapical radiographs showed improvement in the crown-to-root ratios, no adjacent tooth extrusion, and no root resorption (Fig 4, B).

**PATIENT 2**

A 39-year-old man sought prosthodontic care to restore his edentulous regions and improve mastication.
He prematurely lost all mandibular molars due to carious lesions. Consequently, the maxillary first and second permanent molars on both the right and left sides overerupted. Intrusion of these molars was required for prosthetic reestablishment of appropriate function. The patient did not want either extracting and substituting the overerupted molars by implants or subapical surgery for immediate molar repositioning. He decided to undergo selective alveolar corticotomies and orthodontic intrusion.

The extension of the surgical cuts was the only difference in relation to the surgical technique described above. Surgical cuts surrounded both molars on the labial surface and the proximity to the palatine artery limited the vertical cuts lingually. One week postsurgery, orthodontic forces were applied with the modified full-coverage maxillary splint. The maxillary third molars contributed to appliance stability. After 4 months of full-time wear, occlusal plane leveling was observed (Fig 5).

**DISCUSSION**

Posterior teeth that are supraerupted due to early loss of their antagonists are commonly seen in adults without access to dentistry during childhood and adolescence. Conventional treatment options to correct overerupted molars include crown reduction followed by full-coverage restorations or posterior segmental osteotomy to impact the elongated segments. Although still used, both clinical approaches have disadvantages. While the first method usually removes sound tooth structures frequently requiring endodontic treatment and periodontal surgery, the second has the risks associated with general anesthesia and higher costs. Thus, orthodontic intrusion of overerupted molars would increase the quality of the multidisciplinary treatment needed to restore appropriate function in these patients.

Orthodontic treatment efficiency is especially important when treating adults. These patients have specific demands and usually want to achieve their treatment goals as soon as possible to reduce the negative effects of orthodontic appliances in their social and professional lives. An ideal scenario for efficient tooth movement combines well-planned force delivery systems and decreased alveolar trabecular bone density where the resistance against the desired movement is reduced. The optimum force system for molar intru-
sion is obtained when low and continuous forces are applied apically through the tooth’s center of resistance from both the buccal and lingual sides. Adequate anchorage units are also required to eliminate or minimize undesired side-effects from the reactive forces. The previously reported orthodontic approaches for molar intrusion fulfill only some of these requirements.

The modified full-coverage maxillary splint we propose might overcome some limitations of the early methods described for orthodontic intrusion of overerupted molars. Vertical-pull headgears deliver intrusion forces only from the molar buccal surface, and a tipping moment is created. The application of intrusive forces with elastics or elastomeric chains requires frequent reactivations due to early force degradation; this can be impractical for both patient and orthodontist. We suggest superelastic nickel-titanium springs, which permit constant force application over a wide range of activation without requiring frequent checkups. The modifications in maxillary splint design allow the intrusive forces from both the buccal and lingual surfaces, eliminating the tipping moment noticed with high-pull headgears.

Although skeletal anchorage systems solved the need for patient cooperation, anatomical variations can limit ideal micro-titanium screw placement in some patients who require molar intrusion. When mini-implants are not placed correctly, the resultant line of intrusion force passes away from the molar’s center of resistance, generating uncontrolled rotational moments and decreasing intrusion efficiency. The intrusion appliance shown in this article might be a viable alternative when ideal implant positioning is risky or impossible. During appliance construction, the hooks that serve as points of force application are positioned to create a line of force directed apically through the center of resistance of the molars. In addition, the use of the entire occlusion as the anchorage unit for molar intrusion has been successfully reported. However, the dependence on patient cooperation is a disadvantage of the suggested approach. To overcome this limitation, selective corticotomies were performed to increase alveolar bone response, reducing treatment time and consequently diminishing the demand for overall appliance wear.

The successful clinical application of corticotomy-facilitated orthodontics has been shown to reduce treatment time in adults as an intermediate therapy between orthognathic surgery and conventional orthodontics to correct moderate skeletal malocclusions, and before the application of orthodontic forces on overerupted molars. Mostafa et al described successful molar intrusion combining corticotomy and fixed edgewise appliances. Although they did not mention the amount of force applied, rapid movement of the tooth-bone segment without anchorage loss was reported. Hwang and Lee demonstrated the correction of supraerupted molars after performing localized corticotomies and applying orthodontic forces with full-time wear of magnetic appliances and night use of a vertical-pull chin cup. Despite earlier reports that approximately a force of 90 g per tooth is required for...
molar intrusion, a force of more than 90 g was exerted with repelling magnets because the authors believed that heavier forces were necessary to move the bone block with the tooth. The theory of bone-block movement has been used to explain orthodontic movement after alveolar corticotomies since the introduction of this therapeutic approach. However, the postsurgery increase in regional bone turnover was suggested as a more adequate explanation for this phenomenon.

While the influence of corticotomy on alveolar bone physiology and tooth movement has not been directly investigated, indirect evidence might support the increased bone turnover theory. Animal studies showed that orthodontic tooth movement is faster under increased alveolar bone turnover conditions. In addition, the initial bony-tissue response to a traumatic injury is an increase in bone turnover. Based on this evidence, we decided to use orthodontic forces in the range needed for tooth intrusion, applying 100 g per tooth to be intruded.

The results reported here showed 4 mm of intrusion on the maxillary right and left molars within 2.5 months in 1 patient and 3 to 4 mm in 4 months on both the maxillary right first and second molars on the second patient. These findings are similar to those reported by Hwang and Lee. Other orthodontic treatment approaches obtained molar intrusion without previous selective corticotomies. However, the average active treatment time required for complete intrusion was longer. Yao et al. used skeletal anchorage to obtain an average of 3 to 4 mm of intrusion in 7.6 months. Sherwood et al. obtained 4 mm of intrusion in 6.5 months using mini-titanium plates, and Enacar et al. registered approximately 4 mm of intrusion in 8.5 months using a modified transpalatal arch. The results in our patients reported here indicate that the healing stimulus caused by the corticotomies might reduce the overall treatment time required to intrude overerupted molars. However, animal studies and further research with larger clinical samples are needed to better understand how corticotomies affect alveolar bone metabolism and orthodontic tooth movement.

This treatment approach combines a simple and low-cost modified maxillary splint designed to deliver ideal intrusive forces. The use of Sentalloy coils allows constant force exertion over longer periods of time, and the transparent appliance might not compromise esthetics. Incorporating localized corticotomies shortly before orthodontic treatment appears to decrease bony-tissue resistance against the intrusion forces, increasing treatment efficiency and reducing the demand for overall appliance wear and patient cooperation.

This therapeutic approach might be a viable option when skeletal anchorage has risks to the patient or restricts the application of adequate intrusion force direction. It should also be considered if the patient desires a shorter treatment time.

CONCLUSIONS

Successful intrusion of overerupted molars is a significant clinical challenge to orthodontists. Although prosthetic leveling of the occlusal planes might restore sound teeth, subapical interventions for immediate repositioning have surgical risks and higher costs. Therefore, an intermediate alternative to increase treatment efficiency and minimize patient discomfort would be welcome. Our patients demonstrated that combining selective alveolar corticotomies with a full-coverage splint modified to incorporate superelastic nickel-titanium coils can be a viable alternative to efficiently intrude overerupted maxillary molars and reduce surgical risks, treatment time, and costs for both orthodontists and patients.

REFERENCES