Orthodontic Microsurgery for Rapid Dental Repositioning in Dental Malpositions

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Purpose: Malposition of dental elements can be easily corrected when the patient is young; however, the opposite is true for adults. Middle-age patients normally request a rapid solution, but they usually also have associated pathologic features, such as advanced periodontal disease, dental migration, and ankylosis. Shortening the orthodontic treatment time is possible but not easy to achieve. We applied piezosurgical bone cuts to 10 patients affected by different dental malformations to determine the effects of a shorter treatment time.

Materials and Methods: A total of 10 patients (8 women and 2 men) were treated using the monocortical tooth dislocation and ligament distraction technique. We included 5 patients with dental ankylosis (group A, with a range of 4 to 5 mm of dental intrusion into the bone), who presented with at least 4 elements included in the mandible, and 5 preoperative patients affected by maxillary hypoplasia and transverse maxillary diameter reduction (group B, with a range of 6 to 8 mm measured at the first molar palatal cusp).

Results: Dental repositioning was achieved within 18 to 25 days for the dental intrusion group (group A) and within 68 to 150 days for the preoperative group (group B). The average period was 20 days for group A and 100 days for both dental arches in group B. The decrease in orthodontic treatment time was 70% for the ankylosic teeth and 65% for the preoperative group. We observed no periodontal or gingival damage, although all 10 patients experienced moderate edema and pain.

Conclusions: This method of shortening the orthodontic treatment time is simple, and performing osteotomic lines laterally and apically to the tooth radix on the bone has proved useful in reducing the treatment time. In addition, the technique is very easy to use and has a low incidence of side effects.

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Malposition of single dental elements plays a key role in affecting occlusion. Multiple dental and skeletal problems can severely influence facial esthetics. The orthodontic treatment of these defects can be easily accomplished when the patient is young; however, the opposite is true for adults, for whom combined orthodontic surgical treatment is often necessary. Furthermore, patients 30 to 60 years of age usually request a rapid solution to their problem but also often have associated pathologic features, such as advanced periodontal disease, dental migration in defective areas, post-traumatic occlusal problems, ankylosis, and/or the presence of fixed dental elements because of implant insertion. A certain number of these potential patients forgo orthodontic treatment, with their decision influenced by the period necessary for the appliance to be worn. In addition, they request rapid achievement of a good occlusion and facial esthetics using safe procedures and, possibly, with reduced costs. This is even more important in places in which few people can afford medical or surgical treatment.

Therefore, the key for successful treatment of these patients is to shorten the period required for orthodontic treatment by way of a less invasive technique and at affordable costs. Many attempts to achieve a
decrease in the treatment time have been reported.\textsuperscript{1,2} However, the only effective technique to date has been Wilkdontics—selective alveolar decortication associated with alveolar augmentation.\textsuperscript{3} The remarkable accelerated orthodontic treatment they have achieved passes through surgery and takes advantage of the regional acceleratory phenomenon described by Frost\textsuperscript{4} in 1989. The Wilkdontics technique also uses bone grafting. Because orthodontics is a periodontal phenomenon that takes advantage of the dynamics of resorption and apposition related to accelerated bone turnover and the decrease in regional bone densities, in the present study, we sought to apply a technique that could be an alternative to the Wilkdontics technique and, at the same time, take advantage of the cell-mediated process in the periodontal ligament. Vercellotti\textsuperscript{5} introduced a device (Piezosurgery; Mectron Medical Technology, Sestri Levante GE, Italy) that, using microvibrations and dedicated surgical tips, can produce very thin cuts in a safe and selective way. In 2007, Vercellotti\textsuperscript{6} published a report showing precisely how shortening the orthodontic treatment time can be achieved using monocortical tooth dislocation and ligament distraction. We selected 5 patients with dental malocclusion and 5 with dental ankylosis of multiple dental elements and used the microsurgical orthodontics technique with a prototype of an insert that we call a Veronatip. We recorded the degree of inflammation, edema, and omeprazole 20 mg was prescribed once daily for 12 days. The gingival incision must be bev-eled above the papilla, with the scalpel positioned at 45° with respect to the vestibular gingiva on the alveolar area, close to the teeth, and following each tooth enamel margin to avoid retraction and bone resorption. Osteotomies were performed using the new insert (horizontal and vertical osteotomies) and OT8 left and right tips (horizontal mandibular osteotomies; Piezosurgery, Mectron Medical Technology). We performed only 1 full-thickness flap on the vestibular side. The selected cutting power for bone must be set at 1 and the irrigation solution pump level at 4. A vertical inverted Y corticotomy (the osteotomy along the lateral margin of the ideal tooth radix position should be the longer part of the Y, with the apical part of the Y above the papilla) was performed to preserve the interproximal bone. The number and site of the osteotomies varied with tooth form and position. If intrusive movements had occurred, a certain amount of apical bone was removed. If bone was needed for grafting, we harvested it using the OP3 Piezosurgery insert from the apical area, over the tooth root. If the torque on some teeth needed to be changed, we also performed osteotomies on the lingual side. We used 4 back-and-forth 4-0 Vicryl sutures on the vestibular side toward the palatal gingiva, deeper to the papilla to avoid retraction and then used 5-0 nylon sutures to fix the papilla. Edema was evaluated clinically by measuring the soft tissue thickness using a plicometer and photographs evaluated by the surgeon and 2 residents at the postoperative follow-up visits. Edema was scored as light (≤2 mm), moderate (2 to 4 mm), or severe (>4 mm). A buccal straight wire technique was applied, and the ligament distraction was obtained using palatal appliances of lateral conventional radiographs, and periapical radiographs with the O-ring technique to determine the correct position of the osteotomy, monitor the patient postoperatively for periodontal examination, and to provide oral hygiene instructions. Cephalometric studies were performed according to the methods of Arnett and Bergman\textsuperscript{7} and Rick-etts\textsuperscript{8} and were normally combined to double check our surgical planning. All patients provided informed consent for the microsurgical orthodontics technique.

**SURGICAL TECHNIQUE**

Surgery was performed with the patient under local anesthesia (bupivacaine 1:100,000, 4 mL, plus ropivaca-caine 7.5 mg, 4 mL) combined with intravenous sedation (5 mg of midazolam in 100 mL of saline for 60 minutes) after waiting 20 minutes for vasoconstric-tion to take effect. Dexamethasone 8 mg was given 1 hour before surgery and 1 hour after surgery to avoid edema, and omeprazole 20 mg was prescribed once daily for 12 days. The gingival incision must be bevel-eled above the papilla, with the scalpel positioned at 45° with respect to the vestibular gingiva on the alveolar area, close to the teeth, and following each tooth enamel margin to avoid retraction and bone resorption. Osteotomies were performed using the new insert (horizontal and vertical osteotomies) and OT8 left and right tips (horizontal mandibular osteotomies; Piezosurgery, Mectron Medical Technology). We performed only 1 full-thickness flap on the vestibular side. The selected cutting power for bone must be set at 1 and the irrigation solution pump level at 4. A vertical inverted Y corticotomy (the osteotomy along the lateral margin of the ideal tooth radix position should be the longer part of the Y, with the apical part of the Y above the papilla) was performed to preserve the interproximal bone. The number and site of the osteotomies varied with tooth form and position. If intrusive movements had occurred, a certain amount of apical bone was removed. If bone was needed for grafting, we harvested it using the OP3 Piezosurgery insert from the apical area, over the tooth root. If the torque on some teeth needed to be changed, we also performed osteotomies on the lingual side. We used 4 back-and-forth 4-0 Vicryl sutures on the vestibular side toward the palatal gingiva, deeper to the papilla to avoid retraction and then used 5-0 nylon sutures to fix the papilla. Edema was evaluated clinically by measuring the soft tissue thickness using a plicometer and photographs evaluated by the surgeon and 2 residents at the postoperative follow-up visits. Edema was scored as light (≤2 mm), moderate (2 to 4 mm), or severe (>4 mm). A buccal straight wire technique was applied, and the ligament distraction was obtained using palatal appliances of lateral conventional radiographs, and periapical radiographs with the O-ring technique to determine the correct position of the osteotomy, monitor the patient postoperatively for periodontal examination, and to provide oral hygiene instructions. Cephalometric studies were performed according to the methods of Arnett and Bergman\textsuperscript{7} and Rick-etts\textsuperscript{8} and were normally combined to double check our surgical planning. All patients provided informed consent for the microsurgical orthodontics technique.

**Materials and Methods**

A total of 10 patients (8 women and 2 men) were treated using the monocortical tooth dislocation and ligament distraction technique and the Verona-tip. Of the 10 patients, 5 had dental ankylosis (group A, with a range of 4 to 5 mm of dental intrusion into the bone), who presented with at least 4 elements included in the mandible. The remaining 5 were preoperative patients affected by maxillary hypoplasia and transverse maxillary diameter reduction (group B, with a range of 6 to 8 mm measured at the first molar palatal cusp). The pre-treatment screening was performed by us, together with 2 residents. We recorded the medical history and used clinical analysis to exclude any major metabolic pathologic findings. We studied the occlusion with the aid of casts, in which we designed and measured the osteotomy sites and analyzed the teeth position and desired post-treatment position. We used panoramic radiographs, cone-beam computed tomography (Newtom, QR Verona, Italy), frontal and lateral conventional radiographs, and periapical radiographs with the O-ring technique to determine the correct position of the osteotomy, monitor the patient postoperatively for periodontal examination, and to provide oral hygiene instructions. Cephalometric studies were performed according to the methods of Arnett and Bergman\textsuperscript{7} and Rick-etts\textsuperscript{8} and were normally combined to double check our surgical planning. All patients provided informed consent for the microsurgical orthodontics technique.
titanium alloy arch wire and multibracket appliances with self-ligating brackets with 0.22-in. slots (SDS Ormco [Orange, CA], Ultradent Products [South Jordan, UT], 3M [St Paul, MN], and Unitech [Savigny sur Orge, France]) and rectangular nickel-titanium (0.32 in, 0.17/0.25 in, and 0.32/0.32 in) arch wires. Orthodontic refinements were performed, as necessary, using conventional techniques and materials. The antibiotic therapy was amoxicillin 1 g twice daily for 5 days, only in the case of bone grafting. Every patient received a postoperative single dose of ketoprofene (100 mg). The postoperative follow-up examinations were on days 3, 4, 7, and 30 and then every 2 weeks for 2 months. The biomechanical forces were applied for 1 to 7 days after surgery.

Results

The projected dental adjustments were achieved within an average of 18 to 25 days for the dental intrusion group and 68 to 150 days for the preoperative group. The average period was 20 days for the dental intrusion group and 100 days for both dental arches in the preoperative orthognathic group. The decrease in orthodontic treatment time was an average of 70% for the ankylotic teeth and 65% for the preoperative group (Table 1). Group A had an increase in swelling (grade 2) at day 2 in 30% of the patients and slight edema at grade 1 for 70%, with a decrease in the edema by day 7 in 60% of the study population (Table 2). All the patients in group B had an increase in swelling (grade 2) at day 2, with a decrease in the edema by day 7 in 60% of the study population (Table 2). All teeth were sensitive to ice before and after treatment, with a slight pain on chewing that lasted for 15 days. In general, the incision we have used does not produce periodontal pocketing, and the papilla is well preserved.

CLINICAL CASE 1

Case 1 was an 18-year-old man with Class I and severe intrusion of the left premolars and molars without crowding and metabolic pathologic features (Figs 1–3). He requested a rapid solution of the problem because he had been previously treated for dental malocclusion. We performed multiple vestibular osteotomies (Figs 4, 5) and immediately applied strong orthodontic forces. We achieved total occlusal contact within 25 days (Figs 6, 7). The patient did not complain of any of the described side effects.

CLINICAL CASE 2

A 23-year-old woman with Class I and severe crowding of the upper maxilla with transverse diam-

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<th>Table 1. REDUCTION IN ORTHODONTIC TREATMENT TIME AND NUMBER OF TEETH TREATED</th>
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<tr>
<td>Variable</td>
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<th>Table 2. INCIDENCE AND SEVERITY OF SIDE EFFECTS STRATIFIED BY TREATMENT GROUP</th>
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<td>Pain</td>
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<td>Edema at day 2</td>
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<tr>
<td>Group B</td>
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<tr>
<td>Pain</td>
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<td>Edema at day 2</td>
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FIGURE 1. Frontal view of occlusion. Note the deficit in height for lateral inferior group of teeth on left side.


FIGURE 2. Preoperative panoramic radiograph.

eter contraction (Figs 8, 9). She requested a rapid solution of the problem because her wedding ceremony was occurring soon. We performed multiple vestibular osteotomies and immediately applied strong orthodontic forces with the aid of internal and external orthodontic arches (Figs 10, 11). We aligned the upper maxilla teeth within 105 days (Fig 12). The patient did not complain of any of the described side effects.

Discussion

When we think of maxillomandibular surgery, we think of patients requiring surgery because of varying degrees of malocclusion that can be caused by several factors, including the spread of advanced periodontal disease, dental migration toward areas of tooth loss, and tooth movement produced by traumatic occlusal problems, as well as associated congenital skeletal disease. However, although many patients come to us for functional reasons, they also naturally express concerns about what they will look postoperatively and how long the treatment will last before undergoing surgery. Although traditional orthodontic therapy is the standard for treating many adult dental malpositions, when applied to patients with a thin skeletal biotype or...
affected by severe jaw discrepancy, it can be limited by root dehiscence or difficult tooth repositioning. Patients always undergo maxillofacial surgery to correct the most severe skeletal discrepancies and avoid surgery to correct borderline dental skeletal malocclusions. A certain number of patients often forgo orthodontic treatment, particularly because of its duration. The patients we treat with orthodontics and orthognathic surgery could achieve psychological and physical improvement by reducing the treatment time. Traditional orthodontic movement results from periodontal ligament compression, which produces histologic and biomolecular modifications of the periodontal tissues, activating the dynamics of crestal bone resorption and apposition. Therefore, orthodontic movement is considered a “periodontal phenomenon,” and preservation of the ligament is generally difficult because of the long treatment duration. Traditional orthodontic therapy in adult patients often results in protracted treatment times to allay periodontal tissue concerns. Increases in orthodontic forces do not accelerate root movement, because the periodontal tissues cannot overcome the resistance of the alveolar bone without damaging the periodontal ligament and/or root resorption. To overcome the orthodontic limits, several investigators have proposed a simplification of the teeth movement by incorporating bone surgery to possibly reduce the risk of periodontal damage. Several reports have suggested the use of labial/lingual vertical corticotomy with
subapical horizontal osteotomy to correct the tooth positions by way of bony block movement.1-8

By combining strong orthodontic forces and surgery, we can achieve some type of accelerated phenomenon; however, periodontal damage or root resorption can also occur. To prevent this, Liou and Huang9 described an osteotomy technique into the alveolar extraction socket that would accelerate canine distalization into the first premolar extraction alveolus space to a period of several weeks. For treatment of angle Class I crowding, Wilko3 described a “periodontally accelerated osteogenic orthodontics” procedure that included lingual and buccal flaps, bone bur decortication, bone grafting, and fixed orthodontic treatment. This technique reduced the treatment time compared with conventional techniques by 30% to 60% and was based on the rapid acceleration phenomenon but required associated vestibular and palatal/lingual bone cuts and bone grafting. This orthodontic-surgical technique supports the use of osteotomies to aid dental movement and rapid distraction of the periodontal ligament. Surgical alteration of the alveolar bone is performed to reduce mineralization of the crestal bone. However, the decorticated bone must be grafted to achieve an increase in crestal thickness. Microsurgical orthodontics is a surgical-orthodontic technique to speed the dental movement and prevent damage to the periodontal tissues. These goals can be achieved with a piezosurgical device that allows one to perform the piezosurgical technique described by Vercellotti.5 The technique is performed by performing microsurgical osteotomies around each root (Fig 1) and the immediate application of biomechanical forces. This method avoids the heavy compression of periodontal tissue fibers essential for traditional orthodontic movement, thereby preventing periodontal and bone resorption by promoting ligament distraction. Simultaneously, monocortical tooth dislocation acts by periodontal ligament compression in the first phase of treatment, with rapid teeth and bone unit dislocation that generates bone development while the tooth cortical segment is distracted to the correct area. This technique does not require bone grafting and the need to avoid flap perforation is not essential. Also, in select cases, we have performed autologous bone grafts harvested from the same area with the piezo device. The bone cuts were performed using the new insert, which allows the surgeon to be very precise and to perform very thin cuts (0.35 mm). After surgery, the greatest amount of dental movement occurs within the first 30% of the total treatment time, ending with conventional orthodontic treatment.

To overcome the limits of orthodontics, several investigators have proposed a simplification of the teeth movement by incorporating bone surgery to possibly reduce the risk of periodontal damage. Several reports have suggested the use of labial/lingual vertical corticotomy with subapical horizontal osteotomy to correct tooth positions by bony block movement. We used a technique reported by Vercellotti,5 microsurgical orthodontics, but with the addition of a personally designed tip, and recorded the side effects and efficacy. No severe complications were reported, and no patient had complaints regarding the surgery. They were extremely satisfied because of the reduction in the orthodontic time required. We believe this technique is safe and
allows a reduction in treatment time for adult patients, with a low biologic cost.

References
