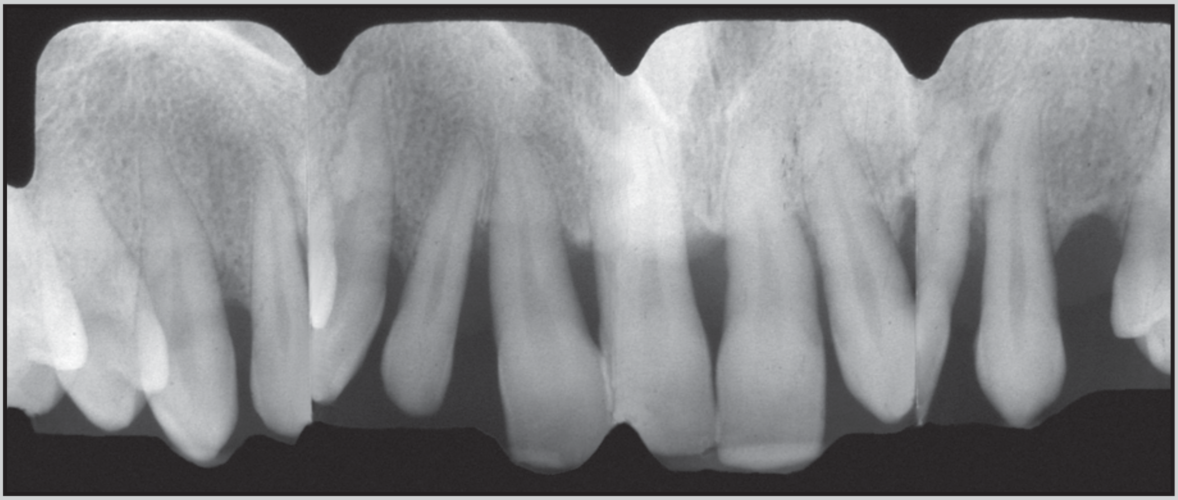

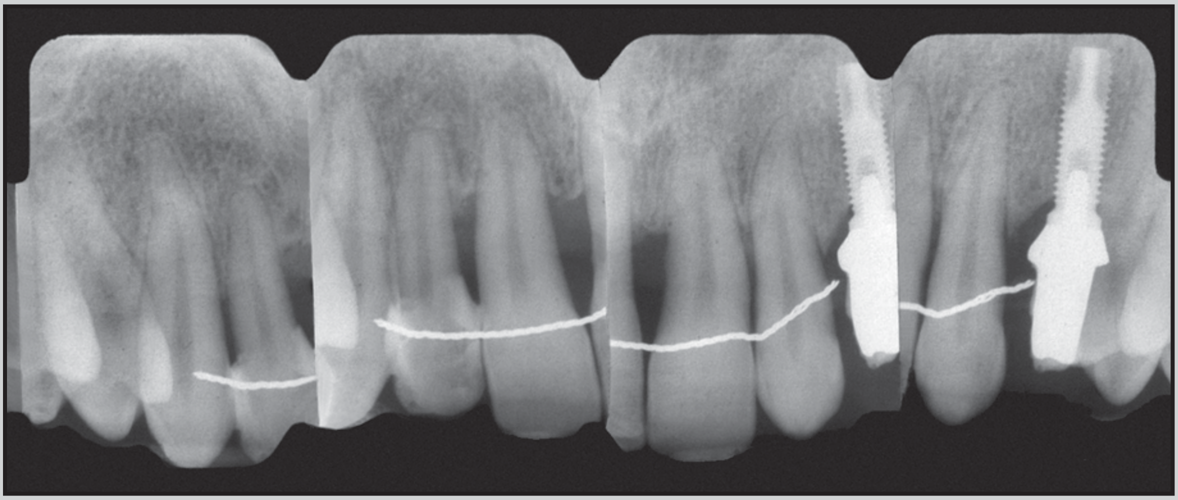

Orthodontic Microsurgery: A New Surgically Guided Technique for Dental Movement

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Eight patients with malocclusions were treated with a new orthodontic-surgical technique that reduces the duration of treatment compared to conventional techniques. The monocortical tooth dislocation and ligament distraction (MTDLD) technique combines two different dental movements that work separately but simultaneously on opposite root surfaces. On the root surface corresponding to the direction of movement, vertical and horizontal microsurgical corticotomies are performed around each tooth root with a piezosurgical microsaw to eliminate cortical bone resistance. The immediate application of strong biomechanical forces produces rapid dislocation of the root and the cortical bone together. On the root surface opposite the direction of movement, the force of dislocation produces rapid distraction of ligament fibers. During the osteogenic process that follows, application of normal orthodontic biomechanics achieves the final tooth movement. All eight patients underwent periodontal and radiologic examinations for more than 1 year after treatment. No periodontal defects were observed in any of the patients, including one with a severe malocclusion and a thin periodontal tissue biotype. Compared to traditional orthodontic therapy, the average treatment time with the MTDLD technique in the mandible and maxilla was reduced by 60% and 70%, respectively. (Int J Periodontics Restorative Dent 2007;27:325–331.)

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Malpositioned teeth are responsible for esthetic and occlusal aberrations in many adults. Malocclusions may 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. However, patients often forgo orthodontic treatment because of its long duration. Traditional orthodontic movement is the result of periodontal ligament compression, which produces histologic and biomolecular modifications of the periodontal tissues that activate dynamics of crestal bone resorption and apposition. Thus, orthodontic movement is considered a "periodontal phenomenon" because all the periodontal tissues are involved. For this reason, preservation of the integrity of the periodontium is generally difficult to achieve and is associated with a long duration of treatment. Although traditional orthodontic therapy is the gold standard for treating many adult dental malpositions, it can be problematic when applied to patients with a thin periodontal biotype, who may experience root dehiscence and/or recession. Also, orthodontic tooth movement may be anatomically limited in cases of severe jaw discrepancy. The treatment of dental-skeletal discrepancies generally requires a combination of orthodontic and orthognathic techniques that must be performed under general anesthesia. Unfortunately, patients often agree to undergo maxillofacial surgery only to correct the most severe skeletal discrepancies and avoid surgery to correct borderline dental-skeletal malocclusions.

Traditional orthodontic therapy in adult patients often results in protracted treatment time 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 damage to the periodontal ligament and/or root resorption.

To overcome these limitations, simplification of the traditional orthodontic movement with bone surgery has been proposed by several authors to simplify tooth movement and possibly reduce the risk of periodontal damage. Several reports[1–4] have suggested the use of labial/lingual vertical corticotomy with subapical horizontal osteotomy to correct tooth positions via bony block movement. Liou and Huang[5] described an ostectomy technique into the alveolar extraction socket that would accelerate canine distalization into the first premolar extraction alveolus space into a time frame of several weeks.

For treatment of Angle Class I crowding, Wilcko et al[6–9] described a "periodontally accelerated osteogenic orthodontics" procedure. This technique includes buccal and lingual flaps, bone bur decortication, bone grafting, and fixed orthodontic treatment. This technique reduces treatment time versus conventional techniques by 30% to 50%.

Orthodontic-surgical techniques support the use of osteotomy to aid dental movement and rapid distraction of the periodontal ligament.[5] Surgical alteration of the alveolar bone is performed to reduce mineralization of the crestal bone. However, the decorticated bone may also be a recipient site for bone graft materials, which can increase crestal thickness.

The authors of this article have developed a new surgical-orthodontic technique to maximize the rapidity of movement and prevent damage to the periodontal tissues. These goals may be achieved with a piezosurgical technique invented and developed by one of the authors (TV)[10–26] that permits microsurgical corticotomy around each root (Fig 1) and the immediate application of biomechanical force. This technique avoids involvement of the periodontal tissue fibers, which is necessary in traditional orthodontic movement, thereby preventing periodontal and bone resorption. The monocortical tooth dislocation technique (MDT) must be considered a new tooth movement because it occurs without periodontal tissue resorption and apposition. Periodontal ligament compression is limited to the first phase of treatment, which involves rapid dislocation of the root and the cortical bone unit. Conversely, the ligament distraction technique (LD) should be considered a "luxation maneuver," which produces a rapid distraction of ligament fibers followed by an osteogenic healing process.

The greatest amount of dental movement occurs in approximately the first 30% of total treatment time with the MTDLD technique. The therapy concludes with the application of conventional orthodontic movement. The present study discusses the surgical techniques for buccal, palatal, and vertical movements.

Method and materials

Pretreatment study

Eight patients (six women, two men) were treated using the MTDLD technique for the following types of malocclusion: deep bite, open bite, and crossbite (Angle Classes I, II, and III). All patients underwent a pretreatment screening, which included medical history, analyses of study casts, cephalometric study, dental radiography, periodontal examination, and oral hygiene instruction. The analyses of study casts allowed evaluation of the necessary dimensions of dental movement, as well as preparation of the necessary fixed and removable bite appliances to eliminate occlusal interference. The cephalometric study was performed to evaluate discrepancies in the maxillary and mandibular positions. Periapical radiographs were used to determine the correct design of the corticotomy. All patients provided informed consent to undergo treatment with the MTDLD technique. Figs 2 and 3 present aspects of the treatment of two patients.

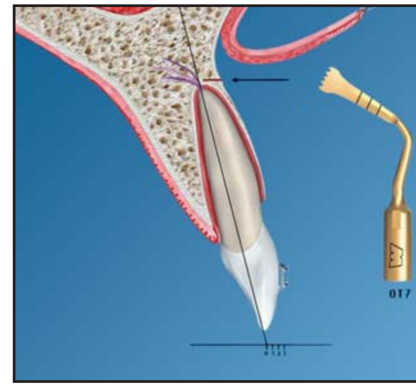
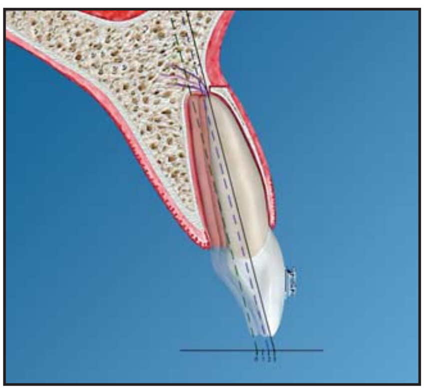


Fig 1a (left) *A microcorticotomy is performed around each tooth root.*

Fig 1b (right) *A periapical horizontal corticotomy (arrow) is performed with the Piezosurgery OT7 insert.*



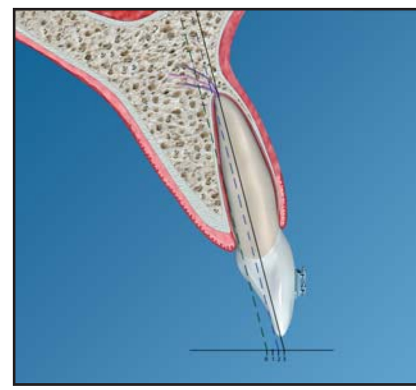


Fig 1c (left) *Buccal monocortical tooth dislocation and palatal ligament distraction movement (MTDLD technique).*

Fig 1d (right) *After healing, there is no modification in crestal bone thickness on the buccal side, and the palatal side has been augmented.*

Surgical technique

All surgery was provided under local anesthesia (Septanest 1:200,000, Septodont). Six patients received an intravenous sedative (a benzodiazepine).

The osteotomies were performed using the 0T7 and OT8 ultrasonic microsaws (Piezosurgery, Mectron Medical Technology). Only one full-thickness flap on the side corresponding to the direction of movement (buccal or palatal) was elevated. The OT7 microsaw was used to perform the vertical and horizontal corticotomies on the buccal side, whereas the OT8 microsaw was used for the horizontal corticotomies on the palatal side. The following settings were used: cutting power, bone 1; irrigation solution pump level, 4.

The corticotomies were performed on the cortical bone in the direction of the dental movement. To expand the maxillary arch, buccal corticotomies were performed; to retract the anterior teeth, palatal corticotomies were performed.

Vertical corticotomies were performed by cutting into the interproximal bone with an internal inclination to the root direction. To preserve the bony crest, the vertical corticotomy finished with two releasing osteotomies next to the adjacent teeth (see Fig 2c).

The number of corticotomies and their design for each patient varied according to root and bone anatomy. The position of the horizontal corticotomy was dependent on the type of movement planned. For arch expansion, the corticotomy was made 1 or 2 mm apical to the root apex (see Fig 1b). To encourage intrusive movement, a quantity of cortical bone corresponding to the amount of desired intrusion was removed (see Fig 3a).

In seven of the patients, the corticotomies were filled with autogenous bone that had been harvested from the apical area of the crestal bone using the Piezosurgery bone chip harvesting technique (OP3 Piezosurgery insert). In two patients, a bone graft substitute (Bio-Oss granules, 0.25 to 1 mm, Geistlich Biomaterials) was used to increase the cortical buccal bone thickness. The grafting material was protected by a resorbable collagen membrane (Bio-Gide, Geistlich Biomaterials).

Fig 2 *Patient 6.*

Fig 2a (above left) *Class I relationship with anterior pathologic diastema in the right maxilla.*

Fig 2b (above right) *Class I molar and Class II canine relationship with absence of lateral incisors and a diastema in the left maxilla.*

Fig 2c (far right) *A vertical "Y" corticotomy is performed to preserve interproximal bone.*

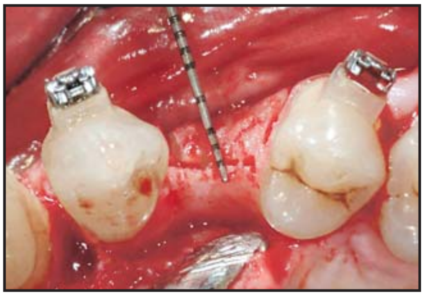


Fig 2d *Edentulous ridge with insufficient width for implant positioning. A horizontal osteotomy for the ridge expansion technique is performed.*

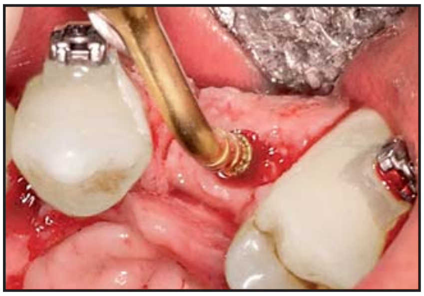


Fig 2e *The Piezosurgery OT4 insert is used for the implant site preparation technique with Piezosurgery.*

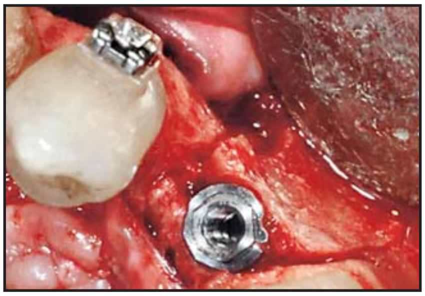


Fig 2f *A 4-mm-diameter implant is placed in the expanded ridge.*

Fig 2g *The postoperative period was characterized by low morbility; soft tissue quality was good at the time of suture removal.*

Fig 2h *Day 0: after indirect bonding.*

Fig 2i *Day 63: Completion of therapy. A provisional crown has been placed on the maxillary left canine implant.*

Orthodontic biomechanics

A buccal straight-wire technique was combined, when possible, with an additional palatal force, which was individualized for each patient.

The cortical bone dislocation and ligament distraction were performed with palatal appliances constructed with titanium-molybdenum alloy archwires (SDS Ormco) (0.32-inch, 0.17- × 0.25-inch, 0.32- × 0.32-inch) and multibracket appliances constructed with self-ligating brackets with 0.22-inch slots (SDS Ormco, Ultradent Products; 3M Unitek) and rectangular nickel-titanium (NiTi) or copper-NiTi archwire. An indirect bonding system that incorporated the Ray Set machine (Biaggini Medical Devices) helped reduce the length of the second phase of treatment. In cases in which alignment and refinement of the occlusion were necessary, biomechanics were performed convention-

Fig 2j (left) *Initial overjet.*

Fig 2k (right) *Final overjet.*

Fig 2l (left) *Malocclusion prior to treatment.*

Fig 2m (right) *The final result 63 days later.*

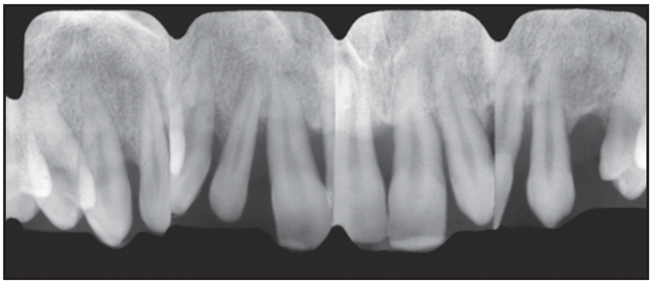


Fig 2n *Radiograph prior to orthodontic-microsurgical treatment.*

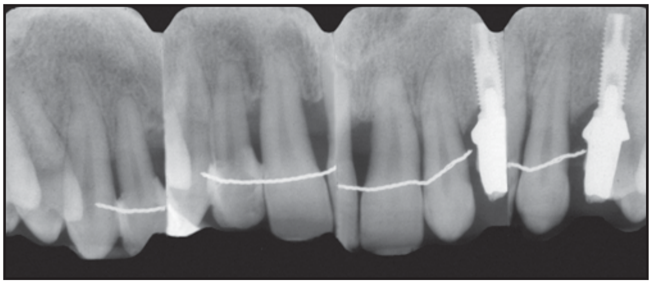


Fig 2o *Radiograph at 3 months after MTDLD treatment.*

ally with individualized NiTi or arch forms.

Six patients were treated in the maxillary arch (one on the palatal side), and two received mandibular treatment.

Postoperative management

Antibiotic therapy consisted of 1 g amoxicillin (Zimox, Pfizer) twice daily for 5 days in one patient after bone grafting. Seven patients were given a single dose of nimesulide (100 g). All patients were evaluated 3 days after surgery and 7 to 8 days after suture removal and interviewed to identify potential postoperative problems. The biomechanical force was applied 1 to 7 days after surgery. For the first month, the patients were evaluated once a week by a periodontist and an orthodontist; during the following month, exams were performed every 2 weeks.

Fig 3 *Patient 5.*

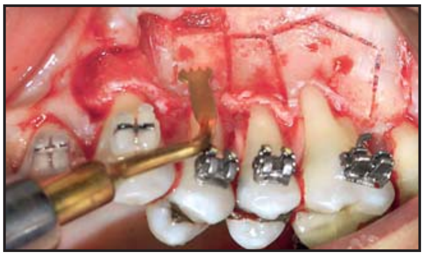


Fig 3a *An apical corticotomy is performed at the first premolar to improve intrusive movement while preserving the sinus membrane.*

Fig 3b *Pretreatment condition. The first premolar is extruded, and severe recession is apparent at the first molar.*

Fig 3c *Final result. The first premolar has been intruded and the root recession at the first molar has been reduced.*

Table 1 Treatment time with the MTDLD technique

Patient/sex	Treatment	Treatment time (d)
1/F	Maxillary expansion	88
2/F	Maxillary expansion	43
3/M	Maxillary expansion	46
4/F	Maxillary expansion	67
5/F	Maxillary expansion	105
6/M	Maxillary expansion	63
7/F	Mandibular intrusion	60
8/F	Mandibular intrusion	149

Results

The desired dental movement was achieved in 43 to 149 days. Average therapy times were approximately 2 months for maxillary expansion and about 3.5 months for mandibular intrusion (Table 1).

Radiographs showed favorable results at 3 months after orthodontic-microsurgical therapy (see Figs 2n and 2o). Postoperatively, slight oral swelling of the soft tissues of the face was visible on day 3 after surgery, especially in the corticotomized area of the maxilla, but no inflammation of the oral tissues was present (see Fig 2g).

Discussion

In conventional orthodontic therapy, movement occurs via crestal bone resorption. Although this biomechanical movement is effective, its application is limited in adult patients. Prolonged and/or strong compression of the periodontal ligament may produce histologic modification of the fibers, as well as ligament ankylosis and root resorption. Orthodontists treating adult patients generally prefer to apply light biomechanical forces to avoid the risk of periodontal damage. However, this method requires a lengthy therapeutic period. The MTDLD technique simplifies orthodontic treatment in adult patients and makes it possible to accomplish complex movements in a relatively short period.

The precision of the Piezosurgery microsaw permits a safe corticotomy around the root. The microinvasive osteotomy is characterized by precision, maximum surgical control, and selective cutting action and facilitates the preservation of the root integrity. Because of the instrument's precision, bone regeneration is more likely. Healing following the use of the Piezosurgery microsaw is rapid, with minimal morbidity.

To date, experience with microsurgically guided orthodontic therapy in adult patients has been limited; however, after 2 years, outcomes with the MTDLD technique in adult patients with malocclusions have been favorable. Radiographic and periodontal examinations have confirmed that the MTDLD technique does not damage tissue. Orthodontic-microsurgical treatment has been shown to be a reliable, quick, and painless technique. For these reasons, it may have widespread application in the orthodontic treatment of adult patients.

Conclusion

The present study introduced a new orthodontic-microsurgical technique that permits new orthodontic movement while lowering the risks of bone resorption and ligament ankylosis. This technique involves the application of a strong biomechanical force on corticotomized teeth via a Piezosurgery microsaw. Dental movement occurs via dislocation of the root and the cortical bone together, without compression of the periodontal ligament and bone resorption. No serious periodontal problems were observed in the eight patients treated with the MTDLD technique and followed for 1 year. Compared to conventional orthodontic approaches, the average duration of treatment in maxillae and mandibles was reduced by 70% and 60%, respectively. Orthodontic microsurgery is associated with minimal morbidity and offers a promising means of improving and simplifying orthodontic therapy in adult patients.

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