Accelerated orthodontic treatments with Piezocision: a mini–invasive alternative to alveolar corticotomies

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ABSTRACT – An increasing number of adult patients are seeking orthodontic treatment and a short treatment time has become a recurring request. To meet their expectations, a number of surgical techniques have been developed to accelerate orthodontic tooth movement. However, these have been found to be quite invasive. We are introducing here a new, minimally invasive flapless procedure, combining micro incisions, piezoelectric incisions and selective tunneling that allows for hard- or soft-tissue grafting. Combined with a proper treatment planning and a good understanding of the biological events involved, this novel technique can locally manipulate alveolar bone metabolism in order to obtain rapid and stable orthodontic results. Piezocision allows for rapid correction of severe malocclusions without the drawbacks of traumatic conventional corticotomy procedures.

1. Introduction

1.1. Alveolar cortocotomies and rapid orthodontic treatments

An increasing number of adult patients are seeking orthodontic treatment and a short treatment time has become a recurring request.

Significant acceleration in orthodontic tooth movement has been extensively reported following alveolar corticotomies since the end of the 19th century.

In 1959, Köle [9] described a surgical procedure combining vertical inter-proximal cortical incisions with a subapical horizontal osteotomy cut from the buccal to the palatal plate. The author explains that rapid tooth movements observed following the surgery are caused by what he believed to be bony “block movements” more or less independent of each other. Subsequently, many authors publish variants of the technique where the subapical osteotomy was removed and where only superficial corticotomy incisions were realized. However, all explained that rapid tooth movements were allowed by the “bony block” movements concept [1, 4, 6, 20].

In 2001, Wilcko [25] introduced a technique combining alveolar corticotomies and bone grafting to prevent the risk of dehiscence and fenestration while increasing the scope of orthodontic corrections. In this conventional approach, cortical incisions circumscribing the roots are made on both the buccal and palatal side following full thickness mucoperiosteal flaps (Fig. 1). The bone graft is then placed facing the teeth to be moved and the flaps are then repositioned and sutured at the papilla. The authors [18] further speculated that the rapid orthodontic movements clinically observed in patients who underwent selective decortication might be due to a demineralization–remineralization process rather than “bony block” movement.

1.2. Biological rationals

In 1981, the orthopedist Frost [5] observed that a surgical wounding of the bone induces an increased bone turnover and a decreased bone density in the immediate surrounding of the surgical site (RAP, Regional Acceleratory Phenomenon). This post-surgical state of...
osteopenia is described as a transient condition, giving way to a complete remission of bone density gradually as physiological healing progresses [7, 10].

Furthermore, many studies underlined a relationship between the rate of tooth movement and the rate of alveolar bone turnover. Verna [23], pharmacologically induced high or low rates of bone turnover and demonstrated that an increased turnover is associated with a displacement significantly faster. These results are consistent with those reported by Midgett [13] and Ashcraft [2].

Recent animal studies have confirmed the Wilcko hypothesis that clinically observed rapid tooth movement following corticotomy may be due to Frost’s Regional Acceleratory Phenomenon and not to the concept of movements known as “bony blocks”.

At the histological level, we reported in the rat a reversible increase in bone turnover following alveolar corticotomy [19]. Three weeks after surgery, osteoblastic and osteocalcic activities were increased by a factor of three and returned to steady state values at eleven weeks postoperative. We also noted that these effects were limited to immediate environment of the surgical site.

Other authors have assessed the quality and quantity of orthodontic movements following corticotomies in the animal model. Ren [17] observed faster tooth movement associated with a significant increase in the rate of bone turnover at the surgical site after corticotomy in the Beagle dog. Mostafa [14] reported twice faster tooth movements after corticotomy in the dog and also attributed this effect to the increased bone remodeling observed histologically and to Regional Acceleratory Phenomenon (RAP).

These findings are consistent with the work of Lino [12] for whom accelerated movements are associated with rapid response in the bone marrow and with a lesser hyalinization. Similar observations have been reported in rats after corticision (increased resorption and apposition) and less hyalinization [8].

Moreover, by comparing orthodontic movement after corticotomies to those obtained after ostetomies, Wang [24] and Lee [11] confirmed the Regional Acceleratory Phenomenon (RAP) as the events responsible for rapid movements.

Displacements by distraction osteogenesis are observed in cases of osteotomies and not following simple corticotomies thus refuting the concept of “bony block” movements.

1.3. Alternatives to conventional corticotomies

Although effective, corticotome techniques described above present significant postoperative discomfort. The aggressive nature of these particular methods related to the elevation of muco-periosteal flaps and to the length of the surgery raised reluctance among both patients and dental community.

In addition, all the authors mentioned above performed the cortical incisions using a bone bur that could potentially damage the roots of neighboring teeth (in case of severe crowding in the anterior mandible).

In 2006, Park [15] introduced the corticision technique and removed the need for flaps elevation by conducting their incisions directly through the gingiva using a blade and a surgical hammer. While significantly reducing the duration of the surgery, this technique does not provide the benefits of bone graft of the Wilcko technique. In addition, the highly aggressive use of the hammer and chisels in the maxilla adds a risk of benign paroxysmal positional vertigo [16].

In 2007, Vercellotti [22] reported a reduction of the orthodontic treatment time by 60 to 70% after corticotome performed by means of a piezoelectric micro-saw. Due to their small size and their precision, piezo-electric cutting inserts realize precise osteotomies without the risk of osteonecrosis [21]. The author removed the lingual flap by performing only vestibular incisions but the elevation of a flap prior to the corticotome was maintained thus only relatively reducing surgical time and postoperative discomfort.

To overcome the disadvantages of other corticotome techniques, we are introducing [3], an innovative, minimally invasive, flapless procedure combining piezoscopic cortical micro-incisions with selective tunneling that allows for bone or soft-tissue grafting.
2. Piezocision: minimally invasive technique of alveolar corticotomy

2.1. Initial periodontal examination and management

Piezocision technique addressing primarily adult patients, a complete periodontal assessment including periodontal probing and full-mouth X-Rays must be conducted.

Systematic scaling (and root planing if indicated) must be performed prior to the surgery in order to remove any inflammation that could jeopardize a successful healing. Any detected osseous lesion should be treated before considering a Piezocision procedure.

Moreover, because of the lack of mucoperiosteal flap elevation in the piezocision technique, we highly recommend the use of preoperative three-dimensional imaging (Cone Beam Computerized Tomography) to locate areas of root proximity as well as the mental foramen (Fig. 2). These images also allow the practitioner to assess the quantity and location of areas where a bone graft would be indicated.

2.2. Surgery (Fig. 3)

The surgery is performed under local anesthesia, a week following the placement of the orthodontic appliance. Gingival vertical incisions are made interproximally below the interdental papilla using a number 15 blade and kept as much as possible in the attached gingiva. These incisions do not require to be extended (micro-incisions) but they must cross the periosteum allowing the blade to come into contact with the alveolar bone. Ultrasonic instrumentation (BS1 insert Piezotome™, Satelec Acteon Group Mérignac, France) is then used to perform corticotomy cuts through the gingival micro-incisions and to a depth of 3 mm. Note that no suture is required except in areas where a bone graft is placed.

At the areas requiring bone augmentation, a tunnel is performed by means of an elevator inserted between the gingival incisions to form sufficient space for receiving the graft. The allograft (Puros, Zimmer) is then placed and the incision sutured (absorbable sutures 5-0).

Typically the graft is performed in case of severe crowding in mandibular anterior region. While only three gingival incisions (between the centrals and distal to the laterals) are necessary for tunneling, we note that the cortical incisions are made between each tooth.

When extractions are indicated, they can be made during the intervention. As RAP obtained by corticotomy is limited to the immediate proximity of the cuts [19], two cortical incisions should be performed facing the extraction site to facilitate rapid closure of the space.

Note that all of the incisions (and the graft when required) are made only buccally. The lingual and palatal approaches of conventional corticotomies disappear.

At the end of the procedure, the patient is placed on antibiotics, nonsteroidal anti-inflammatory drugs and mouthwashes containing chlorhexidine.

Surgical sites should be avoided while brushing during the first postoperative week to allow harmonious gingival healing.

2.3. Orthodontic Follow-up

After surgery, patients are monitored every two weeks for their orthodontic adjustments. The major orthodontic movements are obtained within four months following the surgery emphasizing the transient nature of RAP. From our experience, it appears...
that the majority of cases are dealt within a range of 5 to 9 months depending on the severity of the initial malocclusion.

From a periodontal standpoint, patients are monitored at one week postoperatively and then every month to ensure proper plaque control and reinforce necessary hygiene techniques (Fig. 4).

3. Clinical applications

3.1. Indications

Careful selection of cases is a decisive factor on the clinical success of this technique. Patients should present a stable periodontium without periodontal disease, not be affected with a local or general bone disease or be subjected to a treatment such as immunosuppressive or bi-phosphonate.

Motivation and cooperation of the patient are essential in Piezocision as in corticotomy patients. In fact, the transitory nature of RAP obtained after the surgery requires a frequency of appointments higher than conventional technique to achieve the major movements in the first months of treatment.

From an orthodontic standpoint, the ideal candidate for this procedure presents a class I or a mild class II associated with moderate to severe crowding. Severe deepbites are also corrected in a timely manner following Piezocision. In extraction cases, especially in full Class II patients, the teeth will be extracted during the surgery and two to three cortical incisions will then be performed facing the alveolus (Fig. 5).
Periodontal follow-up of patient in figure 3. (a and b) Pre-treatment panoramic radiograph and full mouth x-rays to evaluate bone level and root proximity for surgical planning. (c, d and e) Healing assessment one week post-piezocision. (f) Post-treatment panoramic radiograph for bone level control. Note that the wisdom teeth will be extracted later on.

Correction of Class II by rapid canine retraction after Piezocision. (a) Two to three cortical incisions are made facing the socket of the extracted tooth and surrounding the teeth to be moved. (b) Before canine retraction phase. (c) Four weeks following placement of the retraction coils (300 g Sentalloy GAC®).
Moreover, the procedure we are describing can be performed in a segmental manner (pre-prosthetic intrusion, treatment of a single arch...) or be incorporated within a comprehensive ortho-surgical treatment plan allowing for rapid decompensation of the arches prior to moving skeletal bases by orthognathic surgery.

Finally, the observed acceleration of orthodontic movements being based on a localized modification of bone physiology, Piezocision may be associated with various orthodontic treatment techniques (buccal braces, lingual braces and Invisalign® ...).

3.2. Advantages

The technique described here presents similar clinical outcomes to those obtained following conventional corticotomy with the advantages of being shorter to perform, minimally invasive and much less traumatic for the patient.

Clinically we observe a decrease in the duration of treatment equivalent to that obtained by corticotomy (Fig. 6). It appears that the majority of even severe malocclusions are resolved within 5 to 9 months. The active treatment times are therefore three times shorter than those usually observed after conventional treatment of similar malocclusion.

When combined with bone grafting, Piezocision allows for an increase scope of treatment including allowing the correction of severe crowding without extraction.

From a technical standpoint, 45 min to 1 h is usually sufficient for a complete surgery on both the maxilla and mandible with bone grafting against three to four hours for traditional techniques.

Furthermore, if conventional methods could be associated with some periodontal complications (mild bone loss and partial loss of interdental papilla), it appears that not raising a flap in the minimally invasive technique avoids those risks.

In addition, for patients presenting ethnic gingival pigmentation, soft tissue incisions can create a cosmetic concern. In fact, each incision may leave a trace without proper repigmentation, thereby causing cosmetic damages in patients with excessive gingival display. Those patients must be warned against potential risk of post-operative scars.

3.3. Disadvantages and limitations of the technique

Because of the lack of muco-periosteal flap elevation, cortical incisions may present a risk of root damage particularly in areas of close root proximity. A risk also exists at the mental foramen. A panoramic radiograph and retroalveolar images of those areas are essential to the preparation of the surgery. The contribution of three-dimensional imaging compensate for the lack of direct vision of the bony structures (Fig. 2).

Extra care is also required as to the location of gingival incisions. It is very important to keep at least 2 mm from the gingival margin to avoid the formation of gingival cleft.

In addition, for patients presenting ethnic gingival pigmentation, soft tissue incisions can create a cosmetic concern. In fact, each incision may leave a trace without proper repigmentation, thereby causing cosmetic damages in patients with excessive gingival display. Those patients must be warned against potential risk of post-operative scars.

4. Conclusion

Piezocision is an innovative, minimally invasive, flapless procedure combining piezosurgical cortical incisions with selective tunneling that allows for bone or soft-tissue grafting. This innovative technique allows for the orthodontic correction of severe malocclusions in less than a semester without the downside of the extensive and traumatic surgical approaches. It offers a shorter surgical time, minimal postoperative discomfort, a high tolerance for patients as well as an improved periodontium.

The Piezocision reveals itself as a powerful tool in the arsenal of multidisciplinary dental team for our adult patients.

Figure 6
Patient presenting a Class I malocclusion associated with severe crowding (8 mm) and 50% overbite. Treatment completed in six months and three weeks with maxillary and mandibular Piezocision from first molar to first molar coupled with a bone graft by tunneling in the inter-canine region of the mandible. Occlusal views: (a) before treatment, (b) four months after Piezocision, (c) six months and three weeks after Piezocision. Note that the major movements are obtained in the first months following the surgery.
Bibliographie


