Int. J. Oral Maxillofac. Surg. 2016; 45: 1059–1064
http://dx.doi.org/10.1016/j.ijom.2016.04.017, available online at http://www.sciencedirect.com

International Journal of Oral & Maxillofacial Surgery

Clinical Paper
Orthognathic Surgery

Minimally invasive corticotomy in orthodontics using a three-dimensional printed CAD/CAM surgical guide

M. Cassetta, M. Giansanti, A. Di Mambro, S. Calasso, E. Barbato
Department of Oral and Maxillofacial Sciences, School of Dentistry, "Sapienza" University of Rome, Rome, Italy

M. Cassetta, M. Giansanti, A. Di Mambro, S. Calasso, E. Barbato: Minimally invasive corticotomy in orthodontics using a three-dimensional printed CAD/CAM surgical guide. Int. J. Oral Maxillofac. Surg. 2016; 45: 1059–1064.

Abstract. The aim of this prospective study was to evaluate the effectiveness of an innovative, minimally invasive, flapless corticotomy procedure in orthodontics. The STROBE guidelines were followed. Ten patients with severe dental crowding and a class I molar relationship were selected to receive orthodontic treatment with clear aligners and corticotomy-facilitated orthodontics. The mean age of these patients was 21 years (range 17–28, standard deviation 6.08 years); the male to female ratio was 2:1. The main outcome was a reduction in the total treatment time to correct dental crowding. The secondary outcomes were periodontal index changes, the degree of root resorption, and patient perceptions of the method used, assessed using the short-form Oral Health Impact Profile (OHIP-14). The occurrence of early surgical complications or unexpected events was also recorded. All patients completed the treatment to correct dental crowding. The average treatment time was reduced by two-thirds. The procedure did not significantly modify the periodontal indices or oral health-related quality of life. No early surgical complications or unexpected events were observed. In short, the results indicate that this new procedure is safe and accelerates tooth movement without periodontal complications or discomfort. However, the efficacy of this procedure must be confirmed in controlled clinical trials.

Keywords: corticotomy; orthodontics; CAD/CAM; minimally invasive; surgical template; 3D printer.

Accepted for publication 25 April 2016
Available online 10 May 2016

The goal of orthodontic treatment is to improve the patient's quality of life through the enhancement of dentofacial functions and aesthetics. Treatment decisions are based on considerations such as the severity of the malocclusion, pre-existing alveolar deficiencies, extraction versus non-extraction protocols, and patient expectations. The orthodontic treatment of adolescent or adult patients can be challenging; these patients often request short treatments.[1,2]

Rapid orthodontic tooth movement with a concomitant reduction in treatment time can be attained through a combination of orthodontic treatment and surgical alveolar corticotomies.[3–7] Corticotomy is defined as any intentional surgical injury to the cortical

bone; this technique has been claimed to dramatically reduce treatment times because the resistance of the dense cortical bone to orthodontic tooth movement is removed.[3,5] With a corticotomy, shallow perforations or cuts are made only in the cortical alveolar bone; in contrast to an osteotomy, the trabecular bone is left intact.[8] Orthodontic force is applied shortly after surgery to produce the desired tooth movement and optimal bone remodelling.

It has been claimed that orthodontic treatment progresses faster and that the results are more stable after a corticotomy, with minimal risks or complications.[3] However, an evaluation of recently published systematic reviews on corticotomy-facilitated orthodontics showed the inclusion of clinical trials that involved only small groups of patients and provided moderate- or low-level evidence.[9,10] The use of corticotomy to accelerate orthodontic tooth movement, although effective, presents significant postoperative discomfort.[9,11] The aggressive nature of these particular methods, due to the elevation of mucoperiosteal flaps and to the length of the surgery, has resulted in a reluctance to employ them among both the patient and dental communities.[12] Initially the cortical incisions were performed using a bone bur that could potentially damage the roots of neighbouring teeth; more recently the corticotomy has been performed by means of a piezoelectric surgery microsaw.[13,14] The use of piezoelectric instruments seems to have several advantages, including a reduction in intraoperative bleeding and surgical trauma, and improved intraoperative visibility.[15,16]

To overcome the disadvantages of the corticotomy, Dibart et al. introduced the concept of 'Piezocision', a procedure that entails small incisions, minimal piezoelectric osseous cuts to the buccal cortex only, and bone or soft tissue grafting.[17] Piezocision is performed under local anaesthesia through a tunnel approach involving approximately 10 vertical interproximal incisions per arch. More recently Milano et al. described a method for combining Piezocision with the use of computed tomography (CT).[18] By creating a three-dimensional (3D) model of the arch, the depth and location of the corticotomies are planned and transferred to a resin surgical guide using a numerically controlled milling machine.

Even more recently, an innovative, minimally invasive, flapless procedure combining piezoelectric surgery cortical micro-incisions with the use of a 3D-printed computer-aided design and computer-aided manufacturing (CAD/CAM) surgical guide has been reported in the literature.[19] Using this technique the cuts are made using a 3D-printed surgical guide, which can reduce the risk of damage to the anatomical structures. The aim of the present study was to evaluate the effectiveness of this new technique. It was hypothesized that corticotomy using a 3D printed surgical guide would decrease the length of time of orthodontic treatment for severe dental crowding in patients with class I molar relationships. It was also hypothesized that this new technique would not be associated with periodontal tissue damage and would not have a negative impact on patient perceptions of the treatment.

Materials and methods

This prospective cohort study was conducted at the department of orthodontics of the study institution between November 2013 and July 2015. The STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for prospective cohort studies were followed. This clinical investigation was conducted in accordance with the ethical principles of the World Medical Association Declaration of Helsinki and was undertaken after informing the patient of the content, risks, and benefits of the study. Written consent was obtained from each participant. The investigation was reviewed and approved by the local ethics committee.

Eligibility criteria were as follows: systemically healthy patient; no clinical evidence of dental caries; good oral hygiene; skeletal and molar class I relationships; severe crowding of both arches (4 mm or more of discrepancy).[20]

The primary outcome was a reduction in the total treatment time to correct severe dental crowding in patients with skeletal and molar class I relationships. The secondary outcomes were changes in periodontal indices, the degree of root resorption, and patient perceptions of the method used. The occurrence of early surgical complications or unexpected events was also recorded.

The patients were treated by a single operator (MC), highly experienced in orthodontics and oral surgery. The minimally invasive, flapless corticotomy procedure combining piezoelectric surgery cortical micro-incisions with the use of a 3D printed CAD/CAM surgical guide was used.[19] Orthodontic force was applied to the teeth immediately after surgery using clear aligners. Before the surgical procedure, polyvinyl siloxane (PVS) impressions of the upper and lower arches were taken and sent to the manufacturer to create clear aligners for the upper and lower arches (Smiletech, Ortodontica Italia, Rome, Italy). When necessary the upper and lower teeth were reduced at each interproximal location by means of diamond-coated finishing strips used for interproximal reduction. This reduction was carried out at different stages of treatment, depending on the degree of access to the interproximal areas at any given stage. In some cases, the extraction of at least one tooth was also planned, due to a lack of space. Every aligner was put in place for 5 days rather than the standard 15 days, the time that is usually necessary to change the aligner. In this way, completion of the orthodontic treatment was planned to take approximately one third of the time needed for conventional orthodontic treatment with clear aligners. After completion of the treatment, the patients used retainers and were instructed to wear them full-time for 1 year, followed by night-time use for an indefinite period (Figs. 1–4).

Fig. 1. Intraoral images obtained prior to the corticotomy-assisted orthodontic treatment of an 18-year-old male patient with class I molar relationship and severe crowding.