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Corticotomy assisted orthodontics: *A review of surgical technique and literature*

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Abstract

Introduction: Corticotomy assisted orthodontic treatment is a promising procedure, the development of which has offered solutions to many orthodontic limitations. This technique has been shown to decrease orthodontic treatment times by a third in some cases. The technique involves selective alveolar decortication in the form of cortical cuts or perforations performed around teeth to be moved.

Methods: Electronic search of the literature directly relating to surgically assisted tooth movement with corticotomy. The searches were carried out up to the first week in December 2013.

Conclusion: Review of literature has shown the potential of corticotomy techniques in improving orthodontic outcomes. The quality of evidence available at present however is low and is mainly centred on case reports

Introduction

There has been a significant increase in the number of patients requesting orthodontic treatment. The number of adults seeking treatment has also dramatically risen. Demands of these patients have also changed; patients are often only requesting aesthetic correction in the shortest possible time. One of the main disadvantages of orthodontics is length of treatment time, with most conventional procedures taking more than one year to complete. The incidences of caries and periodontal disease also increase when treatment is prolonged. Unfortunately many potential orthodontic patients jeopardise their dental health and decline treatment due to these long expected treatment times.

To shorten the time necessary for orthodontic tooth movement, various attempts have been documented in the literature. These attempts can be grouped into three main categories. The first is local or systemic administration of medicines such as prostaglandins[1], interleukins[2], leukotrienes[3] and vitamin D[4]. They can accelerate periodontal regeneration by inducing or hastening orthodontic inflammation, participating in the formation of osteoclasts from precursor monocytes, or improving capillary permeability. The second category is mechanical or physical stimulation. Direct electrical current[5], pulsed electromagnetic field[6], magnets and low energy laser have

been studied[7]. The above methods increase tooth movement speed 0.3 to 1 times according to the literature. However, they are not without problems. The effects of medicines are not specific and can have side effects. Physical stimulation can further have unwanted side effects.

The last category is oral surgery, including gingival fiberotomy, corticotomy anddistraction osteogenesis. The effect of gingival fiberotomy is controversial.[8] Distraction osteogenesis should also not be routine in orthodontic treatment as rapid tooth movement into immature bone regenerating after distraction osteogenesis can lead to severe root resorption.[9] The development of corticotomy assisted orthodontics (CAO) has offered solutions to many limitations in the management of orthodontic patients.

A corticotomy is defined as a surgical procedure where only the outer cortical bone is cut, perforated or modified. The medullary bone is left intact. This is in contrast to an osteotomy where the surgical cut perforates both cortical and medullary bone. CAO claims to have several advantages including reduced treatment time, increased traction of impacted teeth and more post-orthodontic stability.[10]

The evidence base for the success of corticotomy as an adjunct to orthodontic treatment is still developing. The aim of this critical review is to present a comprehensive review of the literature, including, surgical procedures, indications, case selection and appraisal of literature.

Surgical technique and Case selection

CAO can be incorporated in most cases where traditional fixed appliance orthodontic therapy is used. The technique has been shown to be effective in the treatment of Class 1 malocclusions with moderate to severe crowding, Class 2 malocclusions requiring expansion or extractions, and mild Class 3 malocclusions. The orthodontist will plan the tooth movement, identifying the teeth that will provide anchorage and those portions of the arch that will be expanded or contracted. From this a plan for regions requiring corticotomies is

developed. Careful multidisciplinary planning between surgeon and orthodontist is required and both parties should be trained in the technique. Aesthetic considerations should also be discussed with the patient. For example, if a patient presents with gingival recession in an area requiring corticotomy, a connective tissue graft could be placed in conjunction with the surgery.[11]

The surgical technique for corticotomy can vary from author to author as can the mechanism of force applied during the orthodontic phase. The technique described below is commonly used;

Anaesthesia: The surgical phase of the CAO can be performed under local anaesthetic, sedation or a general anaesthetic and is largely based on patient-surgeon discussion.

Flap design: The objectives of the flap design are to provide access to the alveolar bone where the corticotomy is to be performed, provide coverage after surgery and coverage for any grafting material if used, maintain height and volume of the inter-dental tissues and enhance the aesthetic appearance of the gingival form where necessary. Basic flap design is commonly a combination of a full thickness flap in the most coronal aspect of the flap with a split-thickness dissection in the apical portions. Having a portion of the flap split-thickness increases the mobility of the flap and allows suturing with minimal tension. The periosteal layer should be carefully elevated from the alveolar bone surface. Mesial and distal extension of the flap should reach at least one tooth width beyond the corticotomy areas. Flaps should be raised on both surfaces of the alveolus. Preservation of papilla and inter-dental gingival tissues is critical for a successful aesthetic result and many operators have employed papillae preserving flaps. Soft tissues should be handled with care as an adequate blood supply is crucial to the success of corticotomies.

Decortication: The purpose of the decortications is to initiate the RAP response. A mobile segment of bone should not be created. A round bur is commonly used to perforate the cortex while the corticotomies are usually achieved with a piezoelectric surgery unit. Following review of the literature there was no evidence to suggest that any specific pattern, depth or extent of corticotomy was superior to others. The corticotomies are placed on both the buccal and lingual aspects of the alveolar bone. Most authors recommend a vertical groove is placed in the inter-dental space, midway between the root

prominences in the alveolar bone. This grove should extend from a point 2-3mm below the crest of the bone to a point 2mm beyond the apices of the roots. The vertical corticotomies are then connected with a horizontal circular shaped corticotomy. Care must be taken not to extend the cuts near any neurovascular structures.

Selective alveolar decortication is then performed in the form of decortication cuts at points 0.5mm in depth. Some authors also recommend selective medullary penetration to enhance bleeding.[12]

Closure: Primary closure of the gingival flaps without excess tension should be achieved. Sutures should be left in place for a minimum of two weeks. Tooth movement should start one or two weeks after surgery.

Murphy et al[11] suggests the administration of steroids at the time of the procedure enhances patient comfort and clinical healing. Antibiotics and analgesia are administered at the surgeon's discretion. On the other hand, some researchers believe non-steroidal anti-inflammatory drugs should be avoided because they theoretically interfere with the regional acceleratory process.[13]

Orthodontic Phase: The placement of orthodontic brackets and engagement of light arch wires is typically done the week before the surgical phase is performed. However some authors have bracketed after surgery, enabling easier flap manipulation and suturing. In all cases initiation of orthodontic force should not be delayed more than 2 weeks after surgery. This is because a longer delay will fail to take full advantage of the limited time period that the RAP is occurring. Unlike conventional orthodontics, the orthodontic appliance should be activated every two weeks until the end of treatment.

The orthodontist has a time period of 4-6 months to accomplish the accelerated tooth movement. Finishing movements can then occur at normal speeds. Given this limited initial time frame, the orthodontist will need to advance arch wire sizes rapidly, initially engaging the largest arch wire possible. The amount of orthodontic force to be applied is still debated. It is generally accepted with corticotomies heavier forces and more frequent reactivation is needed as compared with conventional orthodontic treatment. The method

of anchorage used will also vary depending on amount of force applied and tooth movement required.[14]

Contemporary Techniques: Wilcko et al[15] later adapted the corticotomy technique by incorporating alveolar augmentation and connective tissue grafting. Wilcko renamed the technique as Periodontal Accelerated Osteogenic Orthodontics. Grafting can be carried out in most areas that have undergone corticotomies. The volume of the graft material used is dictated by the direction and amount of tooth movement predicted, the pre-treatment thickness of alveolar bone and the envisaged need for buccal support by alveolar bone. No data comparing grafting material in conjunction with corticotomies is currently available. Commonly used materials are deproteinised bovine bone and autogenous bone.

Periodontal Accelerated Osteogenic Orthodontics can further be successfully combined with gingival augmentation. This is particularly important to the adult patient who presents with gingival recession. In these situations a subepithelial connective tissue graft is placed over the root surface in addition to the particulate graft placement.

Literature Review

To identify relevant research for review, an electronic search of the literature directly relating to surgically assisted tooth movement with corticotomy was conducted. The searches were carried out up to the first week in December 2013 using the following databases:

1. Cochrane controlled trials register
2. Cochrane Database of systematic reviews
3. PubMed
4. Ovid Medline
5. Embase
6. Cumulative Index to Nursing and Allied Health Literature (CINAHL)

Of the 137 studies identified on initial search of all databases, 114 were excluded with respect to the following exclusion criteria;

1. Studies to be in English
2. Evidence level at case report/series or above. Technical notes, letters, description of techniques and editorials were excluded.
3. Animal studies excluded, although reviewed for inclusion in 'Animal Studies' section.
4. No variations of 'standard' corticotomy technique as described by Wilcko et al. The buccal or palatal cortical bone must be modified in some manner to be included. Studies solely removing inter-septal bone were excluded as were studies which included medullary bone manipulation or any form of osteotomy.
5. The study must have a follow up period to be included.
6. Orthodontic force must be applied with wire/coils and no distraction appliances are used.

The majority of identified literature included case reports and series. 11 review papers were identified with varying quality. A hand search of references in the identified studies was conducted, however no additional relevant literature was found. The total number of papers suitable for critical appraisal was 12.

Example of search terms

1. Tooth movement
2. Orthodont$
3. 1 or 2
4. Corticotom$
5. Decorticat$
6. Periodontal Distraction
7. 4 or 5 or 6
8. 3 and 7
9. Limit 8 to English

Summary of Papers – Table 1

Study	Level of Evidence	Population/Sample	Intervention	Control	Outcome/Results	Comments
Wilcko et al 2009 [16]	Case Report	2 adult patients. Age 23 and 49. Male and female.	Severe upper and lower crowding treated with non-extraction CAO. Bone grafting used.	None	Decrowding complete in 6 months. Total amount of cross arch expansion was 8mm.	CT scans show an increase in alveolar bone width from use of graft material.
Fischer 2006[17]	Clinical trial	6 patients. Age 11-13. Male and female.	Bilateral impacted canines - one side treated with CAO. Randomisation used.	Split-mouth design – one side treated conventionally	28-33% reduction in treatment time for CAO side. Blinding of assessor.	Well designed trial. Appropriate statistical testing. No post operative difference in bone levels or periodontal probing.
Aboul-Ela et al. 2011[18]	Clinical trial	13 patients. Mean age 19. Male and female. Class 2 Div 1 malocclusion.	Extraction of maxillary premolars, retraction of maxillary canines. CAO randomly assigned to one side of maxillary arch.	Split mouth design – one side treated conventionally	Average rate of canine retraction was significantly higher on CAO side; rate was twice as fast during first 2 months.	No statistically significant difference in post operative periodontal health.

Germec et al 2006[19]	Case Report	1 patient. 22 year old female.	Severe anterior crowding, anterior cross bite, Class 3 dental relationship. Lower incisor retraction with CAO.	None	Lower incisor retraction complete in 1.5 months.	Corticotomy only performed on labial side.
Lino et al 2005[20]	Case Report	1 patient. 24 year old female.	Class 1 malocclusion. Protrusive maxillary/mandibular incisors retracted with CAO after first premolar extraction.	None	1 year total treatment time.	
Chung et al 2009[21]	Case series	4 patients. 28 to 50 year old male/female.	Anterior protrusion of maxillary incisors corrected with dental extractions and segmental CAO.	None	10-15 month treatment time.	Anterior segment of teeth moved.
Chung et al 2009[48]	Case series	3 patients. 29-37 years old male/female.	CAO for sagittal correction and open bite correction. Segmental CAO correction with extractions.	None	13 month treatment time.	Corticotomy was staged with buccal cuts two weeks after palatal.
Oliveira et al[22]	Case report	2 patients. 36 year old female. 39 year old male.	CAO for intrusion of over erupted maxillary first molars	None	2-4 month treatment time	
Aljhani et al. 2010[23]	Case report	1 patient. 22 year old female	CAO for anterior open bite and proclined incisor correction	None	5 month treatment time	Alveolar grafting performed.

Moon et al 2005[24]	Case Report	1 patient 26 year old female.	CAO for intrusion of over erupted molar.	None	2 month treatment time	11 month follow-up with no adverse events.
Akay et al 2009[25]	Case report	10 patients (6 females, 4 males) Ages 15-25	CAO for open bite correction	None	15 week treatment time	
Bertossi et al 2011[26]	Case report	5 patients, male and female. Ages not given.	CAO for ankylosis with intrusion.	None	18-25 day treatment time	

Discussion

CAO can play an important role in the comprehensive treatment of a patient's occlusal and aesthetic needs. This technique has been shown to decrease treatment time, enhance post-treatment stability and limit the need for orthognathic surgery. Further advantages include; less root resorption due to the decreased resistance of cortical bone, relapse is reported to the low and there less need for extra-oral appliances and head gear. Bone grafting techniques can also be employed to increase post treatment alveolar bone width as can the incorporation of connective tissue grafts to improve aesthetics and gingival health. Depending on the method of the surgical cuts, CAO can be used to expedite the rate of movement of individual teeth (e.g. canines) or dental segments (e.g. incisor retraction). With CAO, patients will be in fixed appliances for a shorter period than with conventional treatment; consequently there is a decreased risk of enamel decalcification and periodontal disease.

A distinct disadvantage of the procedure is the additional cost and morbidity associated with surgery. Although it could be argued the true increase in treatment cost may be offset by the decreased treatment time or, in some cases, the need for orthognathic surgery procedures.

CAO is a physiologically driven process, and an uninterrupted vascular supply to the operated areas is crucial in maintaining the vitality of the hard and soft tissues. Mobilisation of any outlined single-tooth blocks of bone is contraindicated and can lead to intrapulpal and intraosseous morbidity and will not increase the distance that the tooth can be moved.

Kharkar et al[27] compared dento-alveolar distraction and CAO in their study of 12 patients. Six patients were selected for canine retraction, following premolar extraction, in both maxillary quadrants using CAO and the other six patients using dentoalveolar distraction. The patients were assessed at regular intervals with intra-oral periapical radiographs and lateral cephalograms for gauging the time required for retraction. The results were ascertained by evaluating the two groups in four different parameters: time required, canine tipping, anchorage loss and root resorption. Dento-alveolar distraction

proved to be superior to periodontal distraction in all areas of assessment. However the paper is biased as the corticotomy cuts were only placed in the inter-septal bone, not buccally and lingually which is now standard practice. Furthermore the osteotomy cuts in distraction osteogenesis involve a greater degree of surgical trauma which has been shown to be less accepted by the patients and have been reported to have unpredictable effects on tooth vitality and root resorption.

Because CAO is a relatively new clinical procedure, reliable long-term data (over 5 years) regarding occlusal stability, periodontal health and pulpal vitality is not available. However, current reports with 2 year follow up suggest that CAO can effectively and efficiently facilitate orthodontic treatment with minimal complications. There is low level evidence suggesting the incidence of root resorption by the use of CAO is decreased when compared with conventional treatment. The frequency of other possible complications, such as ankylosis and devitalisation, is unknown but such complications have not been reported. A key component to this increased efficiency and these significantly decreased treatment times is the successful coordination and treatment planning between the orthodontist and oral surgeon.

Currently, no objective data exists that describes patient experience and satisfaction with CAO and few studies quantitatively measure postoperative pain and swelling. However the majority of the case reports reviewed comment on the minimal postoperative pain reported by patients. In order for a fair comparison, an ideal study should look at postoperative pain with corticotomy and compare this with the discomfort experienced with arch wire activation. With the decreased treatment times in CAO it could be assumed this may increase the likelihood that patients, especially adults, would elect to pursue orthodontic therapy when they would otherwise decline. This, however, has not yet been proved. Conversely, it could be argued the surgical phase may in fact prevent a patient from considering CAO as a treatment option.

Conclusion

This review of literature has shown the potential of corticotomy techniques in improving orthodontic outcomes. However, the quality of evidence available at present is low and is mainly centred on case reports which are largely influenced by publication bias. It could be that adverse effects of CAO are not being published in the literature. However the evidence available shows promising results and aims for future research should include randomised controlled trials with long term follow-up. Only then can one evaluate the true advantages and disadvantages of the technique. More research is required to further our understanding of the biological mechanism of CAO and to identify which patients are likely to benefit most from CAO and also to recognise medical and clinical factors where CAO may not be appropriate.

References

Table 1: Example of Clinical Case.docx

Example of Clinical Case:

Palatal Corticotomy for upper left canine tooth showing resisted movement by conventional orthodontics. Note a buccal corticotomy was not carried out in this case due to a thin buccal plate.

Fig 1 . Pre operative view

Fig 2. Palatal Incision

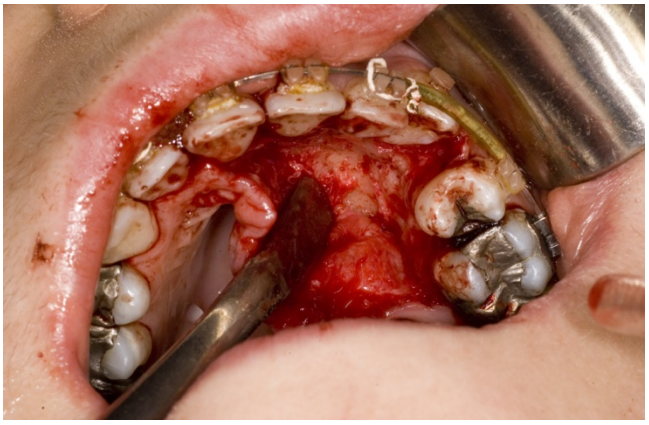

Fig 3. Palatal flap

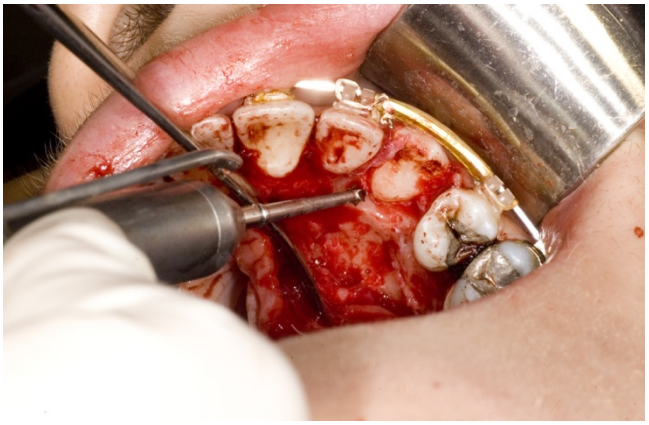

Fig 4. Cortical perforation

Fig 5. Cortical cuts with piezo surgery unit

Fig 6. Final Corticotomy

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