

Review

Corticotomy-Assisted Orthodontic Treatment: A Literature Review

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Abstract: The increased number of adults seeking orthodontic treatment has led to the need for faster results as social limitations arise with the use of fixed or even removable appliances. Corticotomy-assisted orthodontic treatment (CAOT) has been proposed as a technique that accelerates tooth movement and leads to a substantial reduction in treatment time. This review was conducted by searching four databases for original articles about CAOT, review articles and articles about alternative techniques and periodontal effects up to 31 December 2022. The aim of the review was to present the historical and biological background of CAOT, the description of the technique and some alternative and less invasive techniques that have been proposed. Indications, contraindications and periodontal side effects are also discussed.

Keywords: corticotomy; corticotomy-assisted orthodontic treatment; corticision; discision; piezocision



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1. Introduction

Orthodontic treatment tremendously affects dental appearance and overall facial attractiveness, and plays a crucial role in an individual's self-esteem in social settings. Conventional orthodontic treatment requires the dedication of time and patient compliance. Shorter treatment time has always been demanded by patients, but is moreso in this day and age, with every aspect of life being so rushed. The adult population seeking orthodontic treatment seems to be more likely to undergo treatment when there is a potential of decreasing the necessary treatment time. The latter can be achieved by corticotomy surgery, along with the conventional orthodontic technique. Any intentional surgical injury to cortical bone is defined as corticotomy, leaving the medullary bone intact. Alveolar bone decortication was first proposed by Krole in 1959 [1], as he believed that the thicker layer of cortical bone was the main resistance to orthodontic tooth movement. Apart from dramatically reducing treatment time, corticotomy is also used along with conventional orthodontic techniques for the treatment of several types of malocclusions, such as Class I, II or III malocclusions, severe crowding, open bite or deep bite treatment, and it is often used along with temporary anchorage devices.

2. Search Strategy

Four databases (Pubmed, ScienceDirect, Google Scholar, Scopus) were searched by three investigators (AP, NI, PZ) using medical subject headings (Mesh) and a free-hand search up to 31 December 2022. The searched terms used were corticotomy, corticotomy-assisted orthodontic treatment, corticotomy-assisted orthodontics, corticotomy-assisted method or technique, corticotomy and periodontal effects, corticision, discision, piezocision and micro-osteoperforations. Original articles about CAOT, or alternative techniques of CAOT, review articles and articles about the periodontal effects of CAOT were included in

the search. In total, 688 articles were retrieved. The eligibility of articles was determined by reading the title and abstract. Then, full text reading of the selected articles was conducted and finally 70 articles were included in the review.

3. Historical Background of COAT

In 1959, Kole's publication [1] became a stepping stone by introducing the decortication of the alveolar process to achieve tooth movement and prevent relapse. According to Kole, the main resistance to the forces acting in orthodontic treatment comes from the denser layer of cortical bone, and practical experience has shown that when a corticotomy has been performed, quicker tooth movement may be achieved. He believed that by disrupting the continuity of this cortical layer of bone, he was creating and moving bone segments in which the teeth were embedded. These bone segments were connected by the less dense medullary bone, serving as a nutritive pedicle to the periodontium. Kole performed vertical interradicular osteotomy cuts on the cortical layer, both buccally and lingually in its entire alveolar height, and also used a horizontal osteotomy cut supra-apically. At this point, the idea of "bony-block" movement was created to describe the speculated movement post-corticotomy surgery. Kole reported that the major active tooth movements were accomplished in 6 to 12 weeks. Initiation of orthodontic force should take place within 2 weeks after surgery. Periodontal pocket formation or loss of tooth vitality were not observed and radiographically there was no evidence of root resorption. In 1975, Duker [2] repeated Kole's experiment on beagle dogs and proposed a layout that stops at least 2 mm away from the alveolar crest. Duker reported that an incisor segment moved about 4 mm in a matter of 8–20 days without periodontal defects or loss of pulp vitality. In 1978, Generson et al. [3] treated an anterior open bite based on Kole's technique, without the supra-apical osteotomy cut. Over-erupted maxillary molars were treated using the decortication procedure [4]. In 1991, Suya [5] treated 395 adult patients using a technique that he referred to as "corticotomy-facilitated orthodontics", which differed from Kole's technique with the replacement of a horizontal corticotomy cut in place of the horizontal osteotomy cut beyond the apices of the teeth. Suya performed interproximal decortication without linking the buccal and lingual cuts, and this modification became the gold standard for decortication procedures. He recommended completing the major active tooth movements in 3 to 4 months because he assumed that afterwards the blocks of bone would begin to merge together. In 1990, Gantes et al. [6] treated five adult patients using Suya's "corticotomy-facilitated orthodontics" procedure. Mean treatment time was 14.8 months for the experimental group and 28.3 months for the control group. Some apical root resorption was observed, but no loss of tooth vitality or adverse periodontal effects were clinically noticeable. Minimal gingival recession was noted and no attachment loss of clinical significance. In 2001, Wilcko et al. [7] proposed a hypothesis that slowly gained support, which was against the idea of "bony-block" movement. The idea of "bony-block" movement led to almost 4 decades of confusion regarding the correct mechanism of facilitated movement following corticotomy surgery. This misconception ultimately became clear in 2001, when Wilcko et al. [7] compared pre- and post-treatment CT scans of corticotomized patients, which showed a transient localized demineralization/remineralization process consistent with the accelerated wound healing pattern of the regional acceleratory phenomenon (RAP). The Wilcko brothers were the first to introduce Frost's concept of the regional acceleratory phenomenon and introduced a new in-office technique, based on Kole's and Suya's technique, which combined selective alveolar decortication, alveolar augmentation and orthodontic treatment. The main goal was to ensure that only a thin layer of bone was left in the direction of the intended tooth movement. This technique was named "Accelerated Osteogenic Orthodontics" (AOO) or "Periodontally Accelerated Osteogenic Orthodontics", also known as "Wilckodontics", and it was patented [7]. The surgical procedure involves full thickness flap elevation, selective interproximal decortication of buccal and lingual bone of the transported teeth, placement of bone allograft material and securing the flaps in place. The Wilcko brothers detected that demineralization/remineralization of bone was

complete in young teenagers throughout tooth movement, but in adults remineralization did not complete perfectly, so in order to ensure alveolar housing during tooth movement, bone grafting was carried out at the direction of the intended tooth movement [7,8]. This method claims to have several advantages. Bone augmentation expands bone volume around the transported teeth, and consequently reduces fenestration, dehiscence and recession of the gingiva, securing less and slower relapse and long-term stability of the orthodontic treatment. It is also suggested that orthodontic treatment is sped up and that extraoral appliances and orthognathic surgery are less necessary [9–11]. The technique is finally recommended for enhancing expansion, differential tooth movement, increased traction of impacted teeth and post-orthodontic stability, while the orthodontist does not have to rely on the initial alveolar volume and teeth are able to be moved two to three times further in 1/3rd to 1/4th the time needed for conventional orthodontic treatment [7,11].

This results in remodeling of the regional bone, along with inflammation-induced expansion of the periodontal ligament space and temporary local osteopenia. Moreover, at the periodontal ligament and regional alveolar bone of the moving tooth, there seems to be decreased formation and quicker removal of necrotic and hyalinized tissues [10]. The most frequently used grafting materials post-decortication are deproteinized bovine bone, autogenous bone, decalcified freeze-dried bone allograft or a combination [11,12].

Brugnami et al. [13] also combined corticotomy surgery with bone augmentation to increase the scope of conventional orthodontic treatment by allowing for expansive movements beyond the traditional limits. Verna and Melsen [14] reported that bone turnover, bone density and the hyalinized periodontal ligament affect the rate of tooth movement. A more conservative corticotomy technique was reported in order to treat a patient where retraction of the lower anterior teeth was needed. This modification eliminated the lingual vertical cuts and the horizontal cut supra-apically and resulted in reduced surgery time and patient discomfort [15]. It has been stated, with moderate-strength evidence, that corticotomy-assisted orthodontic treatment (CAOT) accelerates the traction of palatally impacted canines in children [16] and also that when dealing with cases of bimaxillary protrusion, CAOT decreases treatment duration [17]. Reduced treatment time of anterior crowding and absence of periodontal problems were reported post-CAOT. Furthermore, apical root resorption associated with orthodontic tooth movement is reported to be decreased [18], while canine retraction after a corticotomy is suggested to be two times quicker in the first 2 months, 1.6 times in the 3rd month and 1.06 times in the 4th month [19].

4. Biological Background of COAT

After many years of confusion regarding the biological aspects of CAOT, the idea of “bony-block” movement was eventually replaced by the regional acceleratory phenomenon (RAP), a concept first described by Harold Frost [20], an orthopedic surgeon. The regional acceleratory phenomenon (RAP) is a complex tissue response to a harmful stimulus of the affected tissues that helps to grow their healing capabilities. It involves the region where the stimulus arises and it is present in both hard and soft tissues. The RAP may serve as an ‘SOS’ mechanism that enhances the healing and regional tissue defense activities against infection and mechanical abuse. For this reason, the RAP is a crucial step for satisfactory bone healing and, as a consequence, healing can be postponed and infections can easily arise if a RAP fails to develop. This intensified bone response includes (apart from the typical signs of inflammation) increased bone turnover and decreased bone density to assist bone healing, as well as increased osteoclastic and osteoblastic activity. Increased levels of local and systemic inflammation markers are also recorded. These tissue responses depend on the duration, power and size of the harmful activity and therefore variability can be noticed. In healthy humans, the RAP typically lasts about four months in bone, a little less in soft tissues and longer for severe than for mild stimuli. According to Frost, any type of significant injury to a human bone usually accelerates its turnover for a year or more. It is suggested [21] that surgical injury causes a temporary

and reversible osteopenia in alveolar bone, which reduces the biomechanical resistance and enables tooth movement through trabecular bone. This phase may be prolonged with orthodontic loading, considering that we have a specific spatiotemporal window that limits the RAP to the teeth surrounded by corticotomy over a range of time (estimated 3–4 months). This is why it is crucial to adjust the orthodontic appliance every 2 weeks [22]. Yaffe et al. [23] carried out experiments in rats and reported that a RAP was observed only at the site adjacent to the corticotomy surgery and that the phenomenon was present just by the elevation of a mucoperiosteal flap, resulting in widening of the periodontal ligament space. Moreover, he stated that RAP in humans begins within a few days of surgery, peaks at 1 to 2 months and may take from 6 to more than 24 months to subside. Lee et al. [24] also performed corticotomies in the mandible of rats, and using micro-computed tomography he reported changes in demineralization/remineralization consistent with a RAP 3 weeks post-surgery at the corticotomy site. Corticotomies on beagle dogs [25] led to the statement that orthodontic tooth movement was increased for at least 2 weeks after surgery and decreased the risk of root resorption. This was attributed to rapid alveolar bone reaction in the bone marrow cavities, which might lead to less hyalinization of the PDL. Experiments on rats [26] showed that 3 weeks after selective alveolar decortication was performed, the catabolic activity (resorption response) and anabolic activity (apposition response) were three-fold higher. Dramatic escalation of demineralization-remineralization dynamics is the likely biologic mechanism underlying rapid tooth movement following selective alveolar decortication. Abbas et al. [27] reported that tooth movement is 1.5 to 2 times faster with corticotomy-facilitated orthodontics, compared to conventional orthodontics and also reported decreased root resorption. The decreased bone density induced by corticotomy surgery to facilitate tooth movement, not only influences the amount but also the modus of tooth movement. Increased tensile stresses in the PDL and decreased compressive stresses have been reported [28]. Furthermore, the alteration of the alveolar density caused by corticotomy was connected to the position of the center of resistance. The center of resistance moved apically as the alveolar bone density declined, but it could not be clinically detected [29].

Wang et al. [30] used a group of rats, performing corticotomies in their mandibles, and reported three phases of bone healing, as shown by the osteoclast counts, immunolocalization of bone markers and blood vessels:

1. A phase of resorption on the 3rd day, with a dramatic initial increase in osteoclasts.
2. A phase characterized by replacement on the 21st day, with more cells resembling osteoclasts and a three-fold increase of the blood vessels. The interradicular bone was replaced by multicellular, fibrous, non-mineralized tissue (that was continuous with the periodontal ligament).
3. A mineralization phase on the 60th day, in which the interradicular multicellular tissue showed primary bone formation.

Corticotomy-assisted tooth movement produced transient resorption of bone surrounding the dental roots under orthodontic tension [30]. Schilling et al. [31] studied the healing phases of RAP in the rat tibia. There is an initial stage of woven bone formation, which begins in the periosteal area and then extends to medullary bone, reaching its maximal thickness on day 7. This cortical bridge of woven bone is a crucial component of RAP, providing mechanical stability of bone after injury. From day 7, the woven bone in the cortical area begins to transform into lamellar bone, but woven bone in the medullary area undergoes resorption, which means transitory local osteopenia.

5. Alternative, Less Invasive Techniques

Recently, flapless modifications of the CAOT technique, such as piezocision and corticision, were introduced in order to reduce the risks related to the conventional technique. The results and healing process seem to be different, although all these techniques involve surgical cortical trauma [32].

5.1. Piezocision

Vercellotti and Podesta [33] performed corticotomies using flap elevations and piezosurgery for rapid tooth movement. After that, Dibart et al. [22] reported on a method of performing only piezosurgery without flap elevation and named it “Piezocision”. This technique includes an interdental gingival incision followed by a corticotomy with a piezo-electric apparatus. If a bone graft is needed, it is performed after dissection under the periosteum and the incision is sutured. Sutures are not required if a bone graft is not performed. This method has the advantage of reducing tissue damage, but it requires a piezosurgery device, and it is not possible for all clinics to have one, due to its high cost.

A study conducted in a 20-patient group by Abbas et al. [27] showed that the rate of tooth movement was reported to be slightly slower than with a conventional corticotomy. Although piezocision has the advantage of being less aggressive and shows less surgical morbidity, the traditional corticotomy technique shows quicker results [34].

5.2. Discision

Not every clinic can afford a piezosurgery device; therefore, Buyuk et al. [35] introduced a technique using a disc saw put into a handpiece. To achieve the removal of the cortical bone, just like in conventional piezocision, the disc saw is placed below the interdental papilla without incisions. The optimal cutting depth is about 3 mm into the bone and between the roots, and there is no need for suturing. The duration of the treatment is 4 months and no complications, such as root resorption or any other pathology, have been recorded. No scar tissue is reported to be observed in any gingival region on which discision is performed [35]. When the process of RAP is considered, orthodontic tooth movement should start one week before the discision procedure, and orthodontic follow-up visits should be scheduled at 3-to-4-week intervals to apply active force [35].

5.3. Corticision

Corticision technically means “cortical bone incision”. Park et al. [36], in an attempt to present a minimally invasive technique, introduced a flapless procedure, named corticision as a different strategy, instead of corticotomies. This method involved placing cortical incisions. For this purpose, the interproximal cortices are separated transmucosally, using a malleting scalpel as a thin chisel. The depth of alveolar penetration is about 10 mm and the length of the vertical cut is about 2/3 of the root length. The effect reaches its peak at 2 months and drops at 3 months after the procedure is carried out.

5.4. Micro-Osteoperforations (MOPs)

Alikhani et al. [37] designed a clinical study trial in a twenty-adult group with Class II Division 1 malocclusion. Micro-osteoperforations were carried out at the first premolar extraction sites of this group. Three holes were formed at the buccal surface of the extraction sockets 5 mm away from the alveolar crest. The researchers used a handheld appliance, which could adjust perforation widths to 1.5 mm and to depths of 2 to 3 mm. The study showed that MOPs increased the rate of canine retraction 2.3-fold compared to the control group and could reduce orthodontic treatment time by 62%.

The effect of MOPs on the expression of the inflammatory markers responsible for the increases in osteoclast activity and the rate of tooth movement was also investigated [38]. In fact, MOPs significantly increased the expression of cytokines and chemokines known to recruit osteoclast precursors and stimulate osteoclast differentiation.

MOPs appear to be a less invasive, comfortable, effective and repeatable surgical method along with common orthodontic appliances. Patients claim that the discomfort and pain after MOPs are mild and unimportant [38].

5.5. Laser-Assisted Corticotomies

The rate of orthodontic tooth movement seems to be favored when performing laser-assisted corticotomies. Low-laser therapy is being applied in moderation due to its invasive nature, even though positive results have been noted [39].

6. Periodontal Effects of CAOT

When performing corticotomy surgery or any of the less invasive techniques mentioned above, it is crucial to keep in mind the different effects that may appear from the periodontal tissues. In terms of Periodontally Accelerated Osteogenic Orthodontics, Bhattacharya et al. [40] noted an increase in thickness of the alveolar bone, whereas Wilcko et al. [41] noted a 0.78 mm increase in the keratinized tissues. Regarding piezocision, no harmful effects were reported on the periodontium in several studies [42,43], while on the other hand, other studies reported increased recessions in some cases that already experienced recessions [44]. Scarring on the gingiva has also been recorded in some cases [45]. Increased recessions were also noted in the study of Yavuz et al. [46] about piezocision and discision. Post-piezocision, no clinically significant loss of clinical attachment has been noted, and 47.5% of cases showed scarring of the mucosa and gingiva [47]. When it comes to increased depth of periodontal pocket, in Baeshen's study about partial corticotomy, some increase was found when heavy orthodontic force was applied and minor root resorption was also found [48]. Sulewska et al. evaluated the PD (probing depth) and CAL (clinical attachment level) where corticotomy was performed and concluded that no periodontal defects were witnessed. Additionally, the values of PD and CAL reduced substantially, which shows how periodontal tissues become stabilized over time [49]. On the other hand, decreased depth of periodontal pocket and increased thickness of keratinized tissues were noted in another study [50]. No periodontal defects or root resorption were found post-corticism, according to Casseta et al. [51]. Similarly, no periodontal defects were noted post-micro-osteoperforations in the study of Alkebsi et al. [52]. Corticotomy surgery was performed along with micro-osteoperforations and bone augmentation in the study of Agrawal et al. [53], and the results were increased thickness of alveolar bone and no root resorption.

The most important studies used in this review about the evolution of the technique and its development and differentiations through the years are presented in Table 1.

Table 1. Important studies on corticotomy and alternative techniques presented in this review.

Author	Year	Type of Study	Sample Size	Technique/Outcome
Kole [1]	1959	Case reports	Large (unspecified) number of patients treated over several years	Corticotomy accompanied by horizontal osteotomy/facilitates orthodontic treatment for several dental malpositions
Duker [2]	1975	Clinical trial	6 beagle dogs	Corticotomy avoiding the marginal crest bone/acceleration of tooth movement
Suya [5]	1991	Clinical trial	395 adult patients	Corticotomy with subapical horizontal cut/significant acceleration of tooth movement and extreme patient satisfaction
Gantes et al. [6]	1990	Case reports	5 patients	Corticotomy/no periodontal adverse effects and mean treatment time 14.5 months

Table 1. *Cont.*

Author	Year	Type of Study	Sample Size	Technique/Outcome
Wilcko WM, Wilcko T, Bouquot JE, Ferguson DJ [7]	2001	Case reports	2 patients	Periodontally Accelerated Osteogenic Orthodontics (PAOO)/decreased treatment time, increased alveolar bone thickness
Wilcko MT, Wilcko WM, Pulver JJ, Bissada NF, Bouquot JE [8]	2009	Case reports	2 patients	Periodontally Accelerated Osteogenic Orthodontics (PAOO)/reduced treatment time in one third of conventional orthodontic treatment
Brugnamì F, Caiazzo A, Mehra P. [13]	2018	Retrospective study	20 patients	Corticotomy with bone graft/maintained the alveolar bone volume around orthodontically repositioned teeth
Germec et al. [15]	2006	Case report	1 patient	Corticotomy/decreased orthodontic treatment time
Yaffe A, Fine N, Binderman I [23]	1994	Clinical trial	60 rats	Mucoperiosteal flap surgery/regional acceleratory phenomenon (RAP) phenomenon occurs
Iino et al. [25]	2007	Clinical trial	12 beagle dogs	Corticotomy/acceleration of tooth movement at least 2 weeks after corticotomy
Wang et al. [30]	2009	Controlled clinical trial	36 rats	Corticotomy/transient bone resorption around the dental roots under tension. Osteotomy-assisted tooth movement resembled distraction osteogenesis
Vercellotti and Podesta [33]	2007	Clinical trial	8	Piezocision/acceleration of tooth movement reduced orthodontic treatment time by 70% for the upper jaw and 60% for the lower jaw
Dibart et al. [22]	2009	Case report	1	Piezocision/acceleration of tooth movement
Buyuk et al. [35]	2018	Case report	1	Discision/accelerated tooth movement
Park et al. [36]	2016	Case report	1	Corticision/acceleration of tooth movement
Alikhmai et al. [37]	2013	Clinical trial	20	Micro-osteoperforations (MOPs)/acceleration of tooth movement
Gibreal O, Hajeer MY, Brad B [43]	2019	Randomized controlled trial	36	Piezocision/acceleration of tooth movement
Charavet et al. [45]	2019	Randomized controlled trial	24	Piezocision/acceleration of tooth movement in cases of mild overcrowding
Strippoli et al. [47]	2019	Clinical trial	12	Piezocision/acceleration of the tooth movement combined with orthodontic treatment

7. Discussion

It is important to keep in mind that corticotomy surgery, as well as the alternative less invasive techniques mentioned above, should be performed by a professional, usually a periodontist, and this is a limitation as the patient has to be treated in more than one medical office. However, the CAOT technique has become a seemingly effective tool for the orthodontist and the adult patient, as it can help to overcome issues such as longer treatment times, absence of growth, periodontal issues and restricted tooth movement due to lack of alveolar bone [54]. Corticotomy can be suggested as a solution to any patient that seeks a shorter treatment time [11,32,55]. It is a well-known fact that corticotomy can be applied to mandibular and maxillary arches. Maxillary and mandibular arch decrowding with normal skeletal relationships and incisor retraction are the main indications for corticotomy [56]. It can also be beneficial for patients who present a Class I malocclusion with moderate-to-severe crowding, Class II malocclusions requiring expansion and/or extractions and mild Class III malocclusions [7] (Table 2). Ferguson et al. [57] suggest that the PAOO technique is the right treatment for severe malocclusions when extrusion is planned for open bite cases, intrusion for deep bites and expansion for posterior cross-bite cases. Corticotomy can be used also in conjunction with skeletal anchorage devices as an alternative option for patients with over-erupted teeth due to loss of the antagonist tooth [32]. Corticotomies combined with skeletal anchorage techniques would be a viable alternative in cases where patients reject orthognathic surgery for correction of anterior open bite. PAOO has been recommended to lessen the need for orthognathic surgery [7,11,58,59]. Regarding the canine retraction after the extraction of premolars, Viwattanatipa et al. [60] confirmed that corticotomy and piezocision accelerated the orthodontic canine retraction. Fischer et al. [16] declared that corticotomy reduces the time of traction of palatally impacted canines by 28–33%. Shoreibah et al. [61] demonstrated that CAOT accelerates space closure and corrects crowding of incisors by 2–2.5-fold in comparison with the traditional orthodontic tooth movement.

Table 2. Indications of corticotomy-assisted orthodontic treatment.

Corticotomy Indications
Arch decrowding for moderate-to-severe crowding in cases of Class I malocclusion
Incisor/canine retraction
Class II malocclusion requiring extractions and/or expansion
Mild Class III malocclusion
Open bite/deep bite cases
Expansion in cases of posterior cross-bite
Treatment of over-erupted teeth
In cases where patients reject orthognathic surgery
Enhancing orthodontic traction of impacted teeth

There are several medical conditions or symptoms where corticotomies cannot be performed (Table 3). Firstly, the patients who present active periodontal disease or gingival recession are not able to receive this treatment [11,62]. In addition, corticotomy-assisted Rapid Maxillary Expansion (RME) is not indicated as an alternative for a severe maxillary constriction like severe posterior cross-bite, which requires surgically assisted palatal expansion [62,63]. PAOO also should be avoided in cases where bimaxillary protrusion is accompanied by an excessive gingival display, which is better to be treated with segmental osteotomy [17]. The latter approach (and not PAOO) is also indicated in patients with relatively normal upper incisor position, a Class I skeletal pattern, relatively poor chin growth and a gummy smile for reducing the lip protrusion [17]. Moreover, patients presenting active endodontic problems or failed endodontic treatments should not be treated using corticotomies [21]. As far as PAOO is concerned, it is suggested that patients who are under corticosteroid treatment cannot be subjected to surgery because the medication suppresses inflammatory reactions [21,64], and the same applies for patients who

are taking any medications that slow down bone metabolism, such as bisphosphonates and NSAIDs [7,64]. Lastly, patients who have been treated with radiation therapy should not undergo a corticotomy because of their reduced blood supply and the less-than-ideal condition of the surrounding soft tissue [65].

Table 3. Contraindications of corticotomy-assisted orthodontic treatment.

Corticotomy Contraindications
Active periodontal disease/gingival recession
Active endodontic problems/failed endodontic treatment
Severe posterior cross-bite cases
Bimaxillary protrusion along with excessive gingival display
Patients under medication with corticosteroids, NSAIDs, bisphosphonates
Patients that underwent radiation therapy

Corticotomy is very effective in accelerating orthodontic movement. However, it can be aggressive because it requires significant flap elevations, which might cause post-surgical discomfort and complications, and hence many patients do not accept this procedure [14]. Al-Naoum et al. [66] performed two-sided corticotomy and indicated that 50% of patients experienced severe pain while eating the day after surgery. The pain slowly decreased within the following 7 days, while almost 60% to 70% of patients experienced no pain or just mild discomfort. The conclusions of the latter study coincide with the findings of Cassetta et al. [58] and Wilcko et al. [6], who concluded that the postoperative pain subsided within a period of 7 to 10 days.

Corticotomy-assisted orthodontics has been accepted as less invasive; however, some complications might happen:

1. Slight interdental bone loss, loss of attached gingiva, periodontal defects. On the other hand, no substantial periodontal defects were observed pre- and post-corticotomy surgery [67]. Düker [2], Suya [5] and Gantes et al. [6] speculated that by keeping the vertical corticotomies 1.5 mm away from the crest of the marginal bone, there would be less chances of damaging the marginal periodontium. Aboul-Ela et al. [19] recommended that a flap design leaving 2 mm of attached gingiva decreased the potential of compromising the periodontal status.
2. Postoperative pain, swelling and subcutaneous hematomas are common when there is short interdental distance, while there is also a risk of infection [11,19,68,69].
3. Some people might experience pain or discomfort during meals for the first few days, but the symptoms, as reported by Al-Naoum et al. [66], are gradually reduced.
4. There were no significant apical root resorption or detrimental effects on root length [67].
5. Pulp vitality in the area of corticotomy is not commonly affected [70], but there has not been any long-term research in the literature [11].

8. Conclusions

The need for accelerated tooth movement and reduced time in orthodontic treatment led to the idea of disrupting the continuity of the cortical bone layer and thus creating and moving bone segments with the embedded teeth rather than just moving the teeth. The option of corticotomy-assisted orthodontic treatment (CAOT) was introduced, with several differentiations proposed afterwards, such as “Accelerated Osteogenic Orthodontics” (AOO) and “Periodontally Accelerated Osteogenic Orthodontics” (PAOO). Less invasive procedures were also introduced: the piezocision, discision, corticision, micro-osteoperforation and laser-assisted corticotomy options.

The regional acceleratory phenomenon (RAP) is the biologic basis for CAOT, and it is characterized by increased bone turnover and increased osteoclastic and osteoblastic activity after the stimulus of corticotomy.

However, the results of CAOT on the degree of tooth movement are limited to a certain time period of a few months, in which orthodontic appointments must be scheduled in shorter-than-usual intervals.

Patients that may be subjected to this treatment modality should be carefully selected based on diagnosis and treatment goals, periodontal condition and medication needs. From this perspective, patients presenting crowding in either the upper or lower dental arch, with normal skeletal relationships and healthy periodontal status who are not under medications that slow down bone metabolism, are good candidates for accepting the option of CAOT during orthodontic therapy.

The less invasive techniques that have been introduced, such as piezocision, discision, corticision, micro-osteoperforations and laser-assisted corticotomies, might be more acceptable by the patient, with fewer disadvantages, but may require special medical devices, and the acceleration in tooth movement compared to CAOT is not well documented and further studies are needed.

As this study is not a systematic review and the articles were not selected under a strict methodology or evaluated for their risk of bias, the conclusions may be subject to re-evaluation.

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