

**RECISATEC – REVISTA CIENTÍFICA SAÚDE E TECNOLOGIA**
ISSN 2763-8405**APPLICATION OF CORTICOTOMY IN ORTHODONTIC TREATMENT: A LITERATURE REVIEW****APLICAÇÃO DA CORTICOTOMIA NO TRATAMENTO ORTODÔNTICO: UMA REVISÃO DE LITERATURA****APLICACIÓN DE LA CORTICOTOMÍA EN EL TRATAMIENTO ORTODÓNCICO: UNA REVISIÓN DE LA LITERATURA**

María Yolanda Yunga Picón¹, Carla Cecilia Llapa Yuquilima², Daniela Lisette Faicán Sislema², Belkis Gabriela Guartazaca², Adriana Estefanía Calle Sarmiento², Javier Enrique Álvarez Chiong³, Milton Fabricio Lafebre Carrasco¹, Mónica Beatriz Dávila Arcentales¹

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ABSTRACT

Corticotomy consists of a surgical procedure that allows cutting, drilling, or mechanically altering the cortical bone, without actually affecting the medullary bone and favoring tooth movement. This technique has provided exceptional results and can be used satisfactorily in orthodontic treatment. Objective: To evaluate and compile the available scientific evidence that supports the application of corticotomy and its effectiveness during orthodontic treatment as an alternative to facilitate tooth movement, as well as its indications, advantages, contraindications, and adverse effects. Methodology: The search for articles was done in electronic databases including PubMed, Google Scholar, ScienceDirect, Dentistry & Oral Sciences Source, and Scielo. 22 articles that meet the inclusion criteria and allow a simple and clear understanding were included in the review. Conclusion: Corticotomy allows for better results and the shortest possible time in orthodontic treatment by applying its different techniques compared to the conventional method. Before the orthodontic procedure, it is necessary to carry out a thorough evaluation of the specific needs of each patient, as well as the treatment expectations. Although corticotomy is a promising technique, there is still little scientific evidence to support its effectiveness.

KEYWORDS: Corticotomy orthodontic. Orthodontic surgery. Orthodontic tooth movement.**RESUMO**

A corticotomia consiste em um procedimento cirúrgico que permite cortar, perfurar ou alterar mecanicamente a cortical óssea, sem afetar de fato o osso medular e favorecer a movimentação dentária. Esta técnica tem proporcionado resultados excepcionais e pode ser utilizada satisfatoriamente no tratamento ortodôntico. Objetivo: Avaliar e compilar as evidências científicas disponíveis que respaldam a aplicação da corticotomia e sua eficácia durante o tratamento ortodôntico como alternativa para facilitar a movimentação dentária, bem como suas indicações, vantagens, contraindicações e efeitos adversos. Metodologia: A busca dos artigos foi feita em bases de dados eletrônicas, incluindo PubMed, Google Scholar, ScienceDirect, Dentistry & Oral Sciences Source e Scielo. Foram incluídos na revisão 22 artigos que atendem aos critérios de inclusão e permitem uma compreensão simples e clara. Conclusão: A corticotomia permite melhores resultados e o menor tempo possível no tratamento ortodôntico, aplicando suas diferentes técnicas em relação ao método convencional. Antes do procedimento ortodôntico, é necessário realizar uma avaliação minuciosa das necessidades específicas de cada paciente, bem como das expectativas de tratamento. Embora a corticotomia seja uma técnica promissora, ainda há poucas evidências científicas para apoiar sua eficácia.

PALAVRAS-CHAVE: Corticotomia ortodôntica. Cirurgia ortodôntica. Movimentação dentária ortodôntica.**RESUMEN**

La corticotomía es un procedimiento quirúrgico que permite cortar, perforar o alterar mecánicamente el hueso cortical, sin afectar realmente el hueso medular y favorecer el movimiento dentario. Esta técnica

¹ Tutor - Faculty of Dentistry, University of Cuenca, Cuenca-Ecuador.

² Student at the Faculty of Dentistry, University of Cuenca, Cuenca - Ecuador.

³ Estudiante de la Facultad de Odontología, Universidad de Cuenca, Cuenca - Ecuador.

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APPLICATION OF CORTICOTOMY IN ORTHODONTIC TREATMENT: A LITERATURE REVIEW

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ha dado resultados excepcionales y puede utilizarse satisfactoriamente en tratamientos de ortodoncia. **Objetivo:** Evaluar y recopilar la evidencia científica disponible que respalda la aplicación de la corticotomía y su eficacia durante el tratamiento de ortodoncia como alternativa para acelerar el movimiento dentario, así como sus indicaciones, ventajas, contraindicaciones y efectos adversos. **Metodología:** La búsqueda de artículos se realizó en bases de datos electrónicas incluidas como: PubMed, Google Scholar, Sciencedirect, Dentistry & Oral Sciences Source y Scielo. La revisión incluyó 22 artículos que cumplen con los criterios de inclusión y permiten una comprensión sencilla y clara. **Conclusión:** La corticotomía permite obtener mejores resultados y en menor tiempo posible en el tratamiento de ortodoncia al aplicar sus diferentes técnicas en comparación con la técnica convencional, previo al procedimiento de ortodoncia es necesario realizar una evaluación minuciosa de las necesidades específicas de cada paciente, así como las expectativas del tratamiento. Aunque la corticotomía es una técnica prometedora, la evidencia científica aún es baja que respalde su eficacia.

PALABRAS CLAVE: Corticotomía ortodóntica. Cirugía ortodóntica. Movimiento dental ortodóntico.

INTRODUCCIÓN

Orthodontic treatment requires a considerable investment of time, and its duration depends on several factors, such as the difficulty of the case, the need for premolar extraction, the experience of the professional, and therefore the collaboration of the patient [1]. There are different methods to accelerate tooth movement and treatment. One of them is corticotomy, described by Heinrich Köle in 1959, which is a surgical procedure that allows cutting, perforating, or mechanically altering the cortical bone without affecting the medullary bone and favoring tooth movement [2, 3]. The objective of this technique is to accelerate the orthodontic movement, which makes it possible to reduce time and undesirable effects such as root resorption, increased biofilm, probing depth, and all the side effects of inadequate diagnosis and treatment in the orthodontic field [2].

In this technique, aspects such as the reduction of treatment duration, possible side effects, and its suitability in specific clinical situations are considered, involving the use of piezoelectric instruments that rotate at low or high speeds, performed with abundant irrigation, which allow the activation of osteoblasts and osteoclasts and promote tooth movement through a positive bone response [1].

To perform corticotomy in a less invasive manner, various techniques have been used, such as the Wilcko Brothers, the Vercellotti-Podesta-Dibart Technique, and the Maino-Parma-Benfenati techniques, all with optimal and efficient results, and some with limitations depending on the needs and characteristics of the patient during orthodontic treatment. Regardless of the technique selected, it is crucial that the planning be performed by an orthodontist and a trained periodontist or surgeon to ensure the success of the procedure and a critical analysis that allows us to provide a complete and balanced view of these techniques, enabling practitioners to make informed decisions and offer high-quality treatment to our patients [3,4].

This article aims to examine and gather the scientific evidence supporting the application of corticotomy, evaluating its efficacy in orthodontic treatment as an option for accelerating tooth movement. Its indications, benefits, contraindications, and possible adverse effects are also analyzed.

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MATERIALS AND METHODS

An electronic search of articles published in English and Spanish in electronic databases including PubMed, Google Scholar, ScienceDirect, Dentistry & Oral Sciences Source, and Scielo was carried out to collect updated data available in the literature. Articles published in the last 6 years were included with the help of the keywords: "corticotomy in orthodontics", "orthodontic tooth movement", "orthodontic movement" and "orthodontic movement". Orthodontic dental movement", "orthodontic surgery" and the Boolean operators "AND" "OR" and "NOT" were used.

Certain criteria were established to determine the eligibility of studies. Articles published between 2019 and 2024 that addressed case-control, literature review, systematic reviews, and longitudinal studies were included. On the other hand, we excluded those not available in full text, lacked the search criteria in the title or abstract, and those published before 2019, only one article from 2018 is included as it has relevant information and serves as a baseline guide.

Initially, a selection was made by reading the titles and abstracts, with a total of 235 articles related to the topic. Subsequently, the introduction of these selected articles was examined to determine whether they addressed the issue of interest, then, a complete reading of the selected articles that were considered potentially relevant was carried out, resulting in 22 articles that support the work performed.

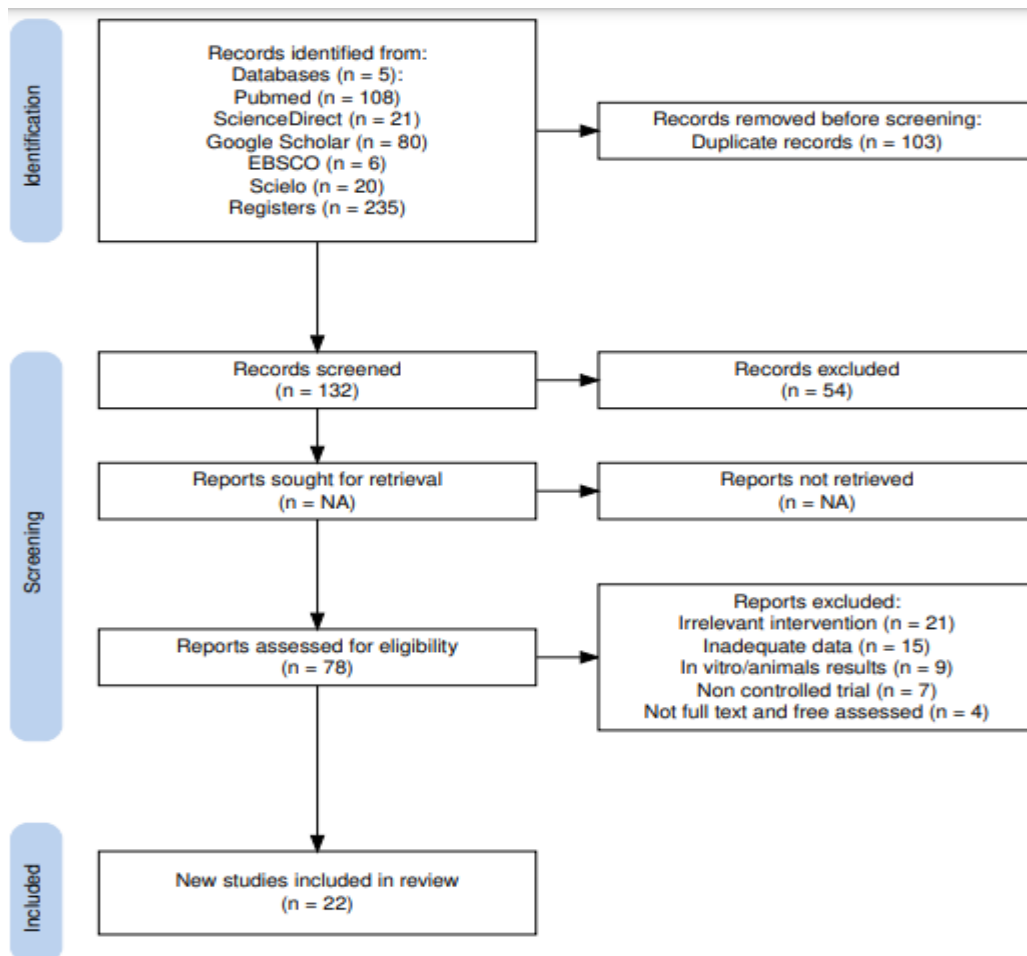


Fig 1. PRISMA method applied to research work
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BIOLOGICAL AND BIOMECHANICAL BASIS RELATED TO ORTHODONTIC DENTAL MOVEMENT

Orthodontic movement is defined as a biological response caused by the application of external forces, these stresses alter vascularization and blood flow in the periodontal ligament releasing neurotransmitters, cytokines, growth factors, and arachidonic acid metabolites [5].

Tooth displacement is due to the biological process of healing damaged bone, during which bone remodeling is initiated with the release of biologically active agents. These agents cause accelerated and increased turnover, recruiting osteoclastic and osteogenic cells. This allows rapid tooth movement and leads to an inflammatory phase resulting in localized bone remodeling. This process includes the widening and fast removal of hyalinized and necrotic tissues from the periodontal ligament, causing the alveolar bone in front of the tooth to shift rapidly [6].

When performing corticotomy, which is a surgical process where micro incisions are made between the interradicular spaces, it provides a favorable biological response of the bone and facilitates such movements, this happens because the alveolar bone loses integrated structure due to the transient demineralization caused after a corticotomy. Remineralization occurs thanks to the collagen bone matrix, which is in charge of healing, therefore, it is where the process of demineralization and remineralization is observed where accelerated dental movements occur [5,7].

MAIN MECHANISMS OF CORTICOTOMY THAT FACILITATE DENTAL MOVEMENT

INDUCTION OF THE REGIONAL ACCELERATORY PHENOMENON (RAP)

Local Osteogenic Response:

Accelerated orthodontic movements are related to the "regional accelerator phenomenon (RAP)" which is a catabolic transformation in which a decrease in bone density is achieved as a biological response to surgical trauma, producing a provisional local demineralization followed by remineralization in the affected area [5, 6, 7].

Increased Bone Remodeling:

Corticotomy increases cellular activity in the alveolar bone, increasing bone resorption and formation. This intensified remodeling facilitates tooth movement by decreasing the resistance of cortical bone to tooth displacement caused by orthodontic force [6,7].

REDUCED BONE STRENGTH

The alteration of the bone architecture facilitates tooth movement because the incisions in the cortical bone reduce its mechanical resistance to tooth movement, which is faster and more efficient, allowing the teeth to move more easily under the influence of orthodontic forces, thus also reducing the time required to achieve the treatment objectives. Particularly beneficial in cases of severe crowding or complex malocclusions [7].



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INTERVENTION TIME FOR THE CORTICOTOMY

Corticotomy can be applied at different times throughout orthodontic treatment, depending on the clinical objectives and the particular needs of the patient [7]. Its application is recommended in the following situations:

START OF ORTHODONTIC TREATMENT

Corticotomy at the beginning of orthodontic treatment facilitates the acceleration of tooth movement, especially useful in cases of significant dental crowding or complex malocclusions. This technique allows rapid activation of the alveolar bone, promoting faster tooth movements and a considerable reduction in total treatment time [7].

INTERMEDIATE STAGES

In some scenarios, corticotomy is appropriate in intermediate phases of orthodontic treatment to address areas that show resistance to conventional tooth displacement. This technique is particularly effective for making fine adjustments in tooth alignment or overcoming bony obstacles that impede desired tooth movement [7].

CORTICOTOMY TECHNIQUES APPLIED IN ORTHODONTICS

Corticotomy was introduced as a surgical procedure to shorten orthodontic treatment time. This technique consists of removing the cortical bone, which strongly resists the applied force while maintaining bone marrow and blood circulation and continuity of bone tissues, thus reducing the risk of necrosis and facilitating tooth movement [3]

INDICATIONS

The application of corticotomy as a complement to orthodontics is recommended in cases of space closure, and open bite by reducing the volume of the anterior cortical bone and intrusion of anterior teeth, scissor bite, and molar rectification [1,2]. There are other aspects such as accelerating canine retraction after premolar extraction and maintaining post orthodontic balance [4]. In addition, it is indicated in severe bimaxillary dentoalveolar protrusion; in class I malocclusion with moderate or severe crowding, in class II malocclusion to avoid expansion or extractions by increasing bone volume and mild class III malocclusion [8].

CONTRAINDICATIONS

The procedure should be avoided in cases of active periodontal infection, gingival recessions, patients with protrusion with a gingival smile, poorly performed endodontic treatments, metabolic bone diseases with bisphosphonate treatment, long-term corticosteroids, non-steroidal anti-inflammatory drugs, patients treated with radiotherapy due to reduced blood supply [4,8].

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ADVANTAGES

Orthodontic treatment using corticotomy techniques to accelerate orthodontic movement time indicates positive aspects. It enhances the speed and limits tooth movement, decreases the need for extractions, reduces treatment time by 6 to 8 months, increases alveolar volume, decreases root resorption, avoids periodontal defect, minimizes periodontal changes such as dehiscence, bone fenestrations, and gingival recession; that is, improving periodontal and bone stability in the long term [4, 8, 9].

ADVERSE EFFECTS

There are few records on the presence or absence of side effects or adverse effects during orthodontic treatment with corticotomy, however, some studies [2,9] mention adverse effects that may occur during the treatment process.

- Root resorption [9].
- Pain and swelling [9].
- Interdental bone loss and decreased attached gingiva [2,9].

Currently, different minimally invasive corticotomy techniques have been reported that allow us to obtain faster and more efficient tooth movements without jeopardizing the long-term stability of the results proposed at the beginning of our treatment plan [3]. Among them, we find:

1. PERIODONTALLY ACCELERATED OSTEOGENIC ORTHODONTICS (PAOO)

This technique was described by Wilcko in 2001 when performing computed tomography studies. The procedure involves raising a mucoperiosteal flap, decorticating the vestibular, lingual, and palatal areas of the alveolar bone, and adding bone graft material beneath the periosteum. For bone grafting, it is necessary to place large volumes of particulate material between the intact raised periosteum and the opposing corticotomized bone. This new bone volume will facilitate more extensive tooth movements and decrease the need for extractions while providing adequate periodontal support [4].

This technique combines orthodontic and periodontal treatment and includes three principles. The first one starts with decortication, which initiates simultaneous processes of repair and production of both progenitor cells and osteoinductive agents. The second principle occurs during the bone turnover process where bone density decreases. Finally, the third principle occurs when bone turnover occurs at a site adjacent to the corticotomy site [10].

Among the indications of this technique are that it improves alveolar bone volume by correcting fenestrations and dehiscences, reduces treatment time, improves post-treatment stability, and rapid recovery of impacted teeth, especially canines. This technique is contraindicated in patients with a thin mandibular cortex, the presence of periodontal disease, posterior crossbite treatment, and maxillary protrusion accompanied by a gummy smile. Clinically, less root resorption occurs, and the time required to treat orthodontic cases with the aid of the PAOO technique was 6 to 8 months [10, 11].

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PAOO developed in three phases:

SELECTIVE ALVEOLAR CORTICOTOMY

A full-thickness flap is used, preserving the aesthetics of the interdental papilla. Subsequently, 0.5 mm deep interproximal cuts are made, limited to the buccal and lingual cortices [11].

BONE GRAFT

The second phase consists of performing alveolar augmentation procedures by placing xenogeneic or autogenous regeneration material in the decortication areas, with the optional placement of resorbable collagen membranes. The flap is sutured with simple nonabsorbable stitches, which are removed 1 to 2 weeks after surgery [11].

APPLICATION OF ORTHODONTIC FORCES

The placement of orthodontic appliances is recommended one week before the corticotomy. Initiation of treatment should be performed after surgery, postponing it for a maximum of 2 weeks. Force activations should be performed every 2 weeks for 4 months [11].

2. PIEZOINCISION OF VERCELLOTTI-PODESTA AND DIBART

This technique described by Vercellotti-Podesta in 2007, called piezosurgery without flap elevation, consists of microincisions at the interdental gingival level without intervening in the palatal/lingual cortex and corticotomy with the use of a piezoelectric device. One of the advantages is that it reduces tissue damage by performing the incision through the tunnel technique and thus reduces vertical incisions with endoscopy-assisted endoscopy [2,12]. It is an option with greater acceptance for molar distalization and root intrusion with lingual torque, being indicated for anterior open bite, deep bite, anterior crowding, and class II [13]. In 2009, Dibart dubbed the technique of corticotomy using a piezosurgical microsaw for 3-mm-deep incisions as piezocision. This technique uses a BS1 cutting tip with abundant irrigation to make an incision through soft tissue and bone, the incision is made in an attached gingiva with a length of 5 to 10 mm and a depth of 1 to 3 mm. A possible complication is root damage during the mucoperiosteal incision [13, 14].

3. MAPA-MAINO AND PARMA-BENFENATI EXCISIONAL TECHNIQUE

MAPA-cision, named after its pioneers, is a simplified regenerative technique recently developed for periodontal orthodontic cases. This innovative method utilizes a minimally invasive piezoelectric surgical procedure designed to facilitate orthodontic tooth movement while increasing bone thickness through guided bone regeneration principles. A novel regenerative device consisting of a resorbable collagen membrane along with filler materials called a "bone bundle" or "small sausage" inserted by tunneling to increase the width of the bone envelope is employed. This allows the teeth to shift within an enhanced periodontal support [15].

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DISCUSSION

The ideal method to accelerate orthodontic tooth movement has been sought for a long time. Surgical intervention has been used in different ways with techniques that allow for achieving the objective of orthodontic treatment.

According to Gao et al (2021), the PAOO method is a suitable option for treating severe malocclusions, especially when extrusion is required in open bite cases, intrusion in deep bites, and expansion in posterior crossbites. In addition, it can be employed in conjunction with skeletal anchorage devices as an alternative for patients with over-erupted teeth due to loss of the antagonist's tooth and to decrease the need for orthognathic surgeries [16].

Although little evidence is available on the increase of keratinized tissue with PAOO, several studies in the article by Xu et al (2020) have revealed a statistically significant increase in bone thickness in groups of patients treated with PAOO compared to others treated with conventional orthodontics. An increase in thickness of 0.43 mm was observed in the PAOO group, possibly attributable to the type of graft material used during the procedure. Although this difference is modest, in cases with thin vestibular bone tables, the application of PAOO offers the advantage of transforming thin bone into a more robust type of bone. This modification may promote additional positive results when combined with corticotomy-enhanced tooth movement. In addition, the inclusion of bone graft material may also reduce the risks of fenestration, dehiscence, and gingival recession associated with orthodontic treatment [17].

Another of the techniques reviewed was the piezocision technique, in an in vivo study Rathod et al (2019); evaluated the speed of tooth movement in a group of ten patients (over 18 years of age) with Class II division I malocclusion or bimaxillary protrusion requiring individual canine retraction after extractions of upper first premolars, compared to the conventional retraction group; the follow-up of the patients in both the experimental and control groups was performed every 2 weeks for the respective activation. The study, resulted in piezocision being 1.5 times faster than conventional, as the rate of space closure in all ten patients was higher on the experimental side compared to the conventional side at all follow-up appointments [18].

Piezocision has been implemented as a minimally invasive technique that stimulates localized bone remodeling and accelerates tooth movement through the use of an ultrasonic device. Gandedkar et al (2024); mention in their article that this technique provides greater bone remodeling, and greater dental movement, as does our review [19], however Gasparro et al (2022); announced in their study that bone remodeling is clinically minimal in the first three months, but the dental movement is not and that this intervention is highly satisfactory for the patient as there are no adverse effects [20].

Adults, when seeking initial orthodontic treatment, not only present malocclusions of varying severities but also face additional restorative and periodontal challenges, which would lengthen treatment time. This is why two types of orthodontic therapy are recommended: complementary therapy and comprehensive therapy. Solanki et al (2022); in their article mention that orthodontic treatment time has been considerably reduced with the incorporation of advanced techniques such as periodontally accelerated osteogenic orthodontics (PAOO) and MAPA-cision because the apical displacement of the

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center of resistance of the tooth optimizes the moments generated by any force applied to the dental crowns, especially in situations where patients have bone loss and it is important to perform a meticulous adjustment of orthodontic forces [21].

The PAOO technique is an effective strategy to accelerate orthodontic treatment without significantly increasing the risk of adverse effects, Zhou et al (2024); in their meta-analysis study demonstrate additional benefits in terms of increased bone density and bone thickness ($p = <0.00001$) statistically significant, which complements the information collected in our study. Similarly, statistically non-significant adverse effects are mentioned that were analyzed in several randomized clinical trials (RCTs) and controlled clinical trials (CCTs), in which no significant differences in root resorption were found in the acceleration of orthodontic treatment, i.e., it does not increase the risk of root resorption. Furthermore, about periodontal parameters, no significant differences were found in terms of probing depth, biofilm index, and gingival index ($p = 0.96; 0.22; 0.34$ respectively), between the groups treated with orthodontic strategies and the conventional groups, being attributed to the strict oral hygiene measures applied to the patients; this information partly refutes what was cited in our article. However, further research is required to confirm these findings due to the heterogeneity and limitations in the current studies [22].

CONCLUSIONS

In conclusion, corticotomy promises to be a valuable and minimally invasive technique within modern orthodontic procedures, allowing acceleration of tooth movement, reduction of treatment duration, greater stability of long-term results as well as unfavorable postoperative effects, making it an efficient option for the correction of malocclusions and other dental problems. However, the quality and quantity of scientific evidence are low to determine the effectiveness of corticotomy and its different techniques in orthodontic treatment. On the other hand, no statistically significant postoperative side reactions were recorded, and insufficient scientific evidence was obtained to support the absence or presence of clinically relevant post-treatment adverse effects. Finally, the importance of a thorough evaluation of the patient's specific needs, dental and periodontal health, the complexity of the case, and the expectations of time and results should be taken into account. In addition, close collaboration between the orthodontist and the patient is crucial in deciding the most appropriate approach to treatment.

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APPLICATION OF CORTICOTOMY IN ORTHODONTIC TREATMENT: A LITERATURE REVIEW

María Yolanda Yunga Picón, Carla Cecilia Llapa Yuquilima, Daniela Lissette Faicán Sislema, Belkis Gabriela Guartazaca, Adriana Estefanía Calle Sarmiento, Javier Enrique Álvarez Chiong, Milton Fabricio Lafebre Carrasco, Mónica Beatriz Dávila Arcentales

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