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Review Article

Periodontally accelerated osteogenic orthodontics- A Literature review

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ABSTRACT

Periodontics and Orthodontics often relates to a symbiotic relationship. Corticotomy was introduced as a surgical procedure to shorten orthodontic treatment time. This procedure involves the removal of cortical bone that strongly resists orthodontic force in the jaw. Though there are numerous studies done in the literature on PAOO, this review mainly focuses on the various comparative studies employed under this procedure. On the other hand, various modifications of this method such as minimally invasive techniques have been introduced to reduce the patient's discomfort due to surgical intervention and complications after surgery. The present review focuses on the history of corticotomy, its mechanism of action, and various comparative studies done under PAOO.

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1. Introduction

The interrelationship between orthodontics and periodontics often resembles symbiosis. Many patients seek the orthodontic corrections to improve their masticatory efficiency and for the proper alignment of teeth to enhance their esthetics. Placement of brackets or braces during the growth spurts stage is highly efficient, whereas the relapse in the treatment is commonly seen in adult orthodontic treatment. The loss of periodontal support may lead to pathological tooth migration which causes displacement of the tooth. The significant corrections in orthodontics include tooth movements alone, or surgical corrections alone or sometimes both. Various corticotomy procedures have been introduced to correct malocclusions in adults. Conventional orthodontic appliances combined with periodontal surgical procedures can dramatically accelerate teeth movement and post-treatment stability.¹ Periodontally Accelerated

Osteogenic Orthodontics (PAOO) treatment is also known as “Alveolar osteogenic orthodontics” or “Wilckodontics”. Periodontally accelerated osteogenic orthodontics has the apparent advantage of shorter treatment duration and the ability to move teeth farther with decreased side effects. This procedure also aims in improving the structural integrity of periodontium as it augments, reshapes, and provides additional bone support as a method to correct preexisting bony fenestrations over root prominences.¹

1.1. Historical aspects

The historical perspective in the corticotomy was initially laid by L.C Bryan in year 1893.² later many studies were done and experimented clinically in the mid 1900's. Henrich Kole³ in 1959 suggested that the presence of the dense cortical layer forms the greatest hindrance during the orthodontic tooth movement. Kole's procedure involved the reflection of full thickness flaps to expose buccal and lingual alveolar bone, followed by interdental cuts through

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the cortical bone and barely penetrating the medullary bone (corticotomy style). The subapical horizontal cuts connecting the interdental cuts were osteotomy style, penetrating the full thickness of the alveolus. Because of the invasive nature of Kole's technique, it was never widely accepted.

Düker used Kole's⁴ investigated the tooth movement with a basic technique on beagle dogs assessing the corticotomy effects on vitality of the teeth and also on the marginal periodontium. The health of the periodontium was preserved by avoiding the marginal crest bone during corticotomy cuts. They have concluded that neither the pulp nor the periodontium was damaged following orthodontic tooth movement after corticotomy surgery. The results helped to substantiate the belief regarding the health of crestal bone in relation to the corticotomy cuts. R. David Rynearson, in 1987⁵ conducted corticotomy facilitated orthodontic movement on a non human primate *Macaca fascicularis*, where they have stated that corticotomy procedures do facilitate tooth movement; however, it moves more quickly through the alveolar bone. Because the tooth movement mechanism at the cellular level is very complex and potentially involves the immune system, this area requires further study.

While closing the extraction spaces, Lino et al and Gantes et al.⁶ stated that if space closure is performed at first premolar sites with only circumscribed corticotomy cuts or with inadequate done thinning such as partial osteotomies, the space closure can take 7 or more months to complete. This can result in total treatment times expanding to a year or longer. However, if bone is thinned adequately in the direction of intended tooth movement, premolar site closure can be accomplished in 3 to 4 weeks with orthopedic forces or in 6 to 8 weeks with lighter orthodontic forces. Space closing cases can be routinely completed in 8 to 10 months or less.

Surgical orthodontic therapy which was introduced by Wilcko et al. included the innovative strategy of combining corticotomy surgery with alveolar grafting in a technique referred to as Accelerated Osteogenic Orthodontics (AOO) and more recently to as PAOO. This technique is safe, effective, and extremely predictable, associated with less root resorption and reduced treatment time, and can reduce the need for orthognathic surgery.⁷

1.2. Surgical procedure of PAOO

1.2.1. There are 5 important steps done in PAOO

This procedure can be implemented in both maxillary and mandibular arches. Correcting the malocclusion with PAOO may hasten the results when compared the conventional orthodontic therapy.

1.2.2. These includes

1. Raising of the intraoral flap

2. Decortication
3. Grafting procedure
4. Flap closure and application of orthodontic forces for tooth movement.

- (a) The flap design should be maintained such that it should provide adequate access to the operating site for the corticotomies to be performed. It is very crucial to maintain the proper gingival contours for proper esthetic appearance. Flap design is a combination of a full thickness flap in the most coronal aspect of the flap with a split-thickness dissection performed in the apical portions.⁸ Vertical releasing incisions may are not required. Between the maxillary central incisors the interdental papilla should be preserved for esthetic considerations. Access to the labial alveolar bone in this area is achieved by "tunneling" from the distal aspect.⁸
- (b) Decortication: It is the process of removing of the cortical portion of the alveolar bone. Local anesthesia is administered and flap elevation is performed. After flap elevation, decortications of bone adjacent to the malpositioned teeth is performed by using low-speed round burs under local anesthesia. In the PAOO procedure, decortication is performed at clinical sites without entering the cancellous bone, avoiding risk of damage to underlying structures, such as the maxillary sinus and the mandibular canal. The corticotomies may also be achieved by piezoelectric knife.^{9,10} The corticotomies are placed on both the labial and lingual (palatal) aspects of the alveolar bone.⁸The decortications should not completely make the bony segments mobile rather it should just initiate the rapid acceleratory phenomenon(RAP).
- (c) Grafting: The materials most commonly used for grafting after decortication are deproteinized bovine bone, autogenous bone, decalcified freeze-dried bone allograft, or a combination thereof.⁸ Grafting is done at those sites where the cortication has been performed. The volume of the graft material used is dictated by the direction and amount of tooth movement predicted, the pretreatment thickness of the alveolar bone, and the need for labial support by the alveolar bone.²
- (d) Closure Techniques: The flap should be approximated using non resorbable simple interrupted sutures without creating excessive tension. Surgical packing may not be required. The placement of orthodontic brackets and activation of the arch wires are typically done the week before the surgical aspect of PAOO is performed. After flap repositioning, an

immediate heavy orthodontic force can be applied to the teeth and in all cases initiation of orthodontic force should not be delayed more than 2 weeks after surgery. A longer delay will fail to take full advantage of the limited time period that the RAP is occurring.²

Indications and Clinical Applications: Several clinical applications for PAOO have been reported.^{6,10-15} These applications include the following:

1. Resolve Crowding and Shorten Treatment Time
2. Accelerate Canine Retraction after Premolar Extraction
3. Enhance Post-Orthodontic Stability
4. Facilitate Eruption of Impacted Teeth
5. Facilitate Slow Orthodontic Expansion
6. Molar Intrusion and Open Bite Correction
7. Manipulation of Anchorage.

1.2.3. Contraindications and limitations

Patients with active periodontal disease or gingival recession are not suited for this procedure. PAOO also should not be used in cases where bimaxillary protrusion is accompanied with a gummy smile, which might benefit more from segmental osteotomy.¹³

1.2.4. Various comparative studies done in PAOO

The field of dentistry has evolved with many interdisciplinary methods which have shown promising results in the treatment outcome. Although corticotomy procedures includes various steps there are many studies done under each step of corticotomy procedure and this article focuses on the comparative studies done in PAOO. Four electronic databases (PubMed, SCOPUS, Google Scholar, Embase) were searched for the comparative studies available under PAOO and around 22 comparative studies were found which included different procedures done in corticotomy, bone grafting, radiographic evaluations of bone densities etc.

Bhattacharya et al¹⁶ included 20 patients for maxillary anterior teeth retraction and compared the procedure done with corticotomy and without corticotomy under CT scan. Their results suggested that the treatment time was decreased in test group and addition the bone graft facilitated adequate support for teeth and overlying structures. It was also found that the alveolar thickness at the middle and apical levels of the teeth was significantly increased post operatively. Sangeetha singh et al¹⁷ compared orthodontic treatment and PAOO following the orthodontic treatment in 30 patients in adult bimaxillary dentoalveolar protrusion cases and reported that PAOO along with orthodontic tooth movement has shorter treatment time and these patients also has shown a stable periodontal health when compared with conventional orthodontic patients.

Naoum et al¹⁸ in a group of 30 patients assessed the pain and discomfort levels during corticotomy which were randomly divided into test and control groups. When compared using a digital caliper, it was suggested that the space closure velocity of the retracted canine was faster on the test side and corticotomy procedure was accompanied by moderate degree of pain and discomfort when recorded on a likert scale postoperatively.

Corticotomy procedures are done usually with the surgical burs. In recent years these are done with many advances too. Piezosurgery, lasers, modified corticotomy procedures facilitated better treatment improvement. Abbas et al¹⁹ in 2016 divided 20 patients in the age group of 15 to 25 and compared conventional corticotomy and piezocision corticotomy done with a piezotome. After 3 months of follow-up, they have stated that the canine retraction was possible in both the methods but the rate of retraction was faster in piezo group than control group. The resorption of root in control group was more than the test site. They also stated piezo being flapless procedure has added advantages on healing rates. Supreet et al²⁰ compared the use of surgical bur and piezocision in 40 patients operated under PAOO for 12 months. Their results suggested negligible root resorption in both the groups and less treatment time was needed for the piezocision. Gibreal et al²¹ and Charvet et al²² assisted the piezo based decortications in adults and reported that piezo took 59% less treatment time when compared with conventional orthodontics.

Pavan et al²³ conducted a split mouth study in 16 patients which included buccal and lingual corticotomies on the right side and only the buccal corticotomy on the left side and evaluated the bone density and reported no significant difference between right and left arches in bone densities after radiographic evaluation. Agarwal et al²⁴ in a split mouth study compared PAOO with flapless micro osteo perforation (MOP) assisted orthodontic treatment in which they used 6 to 7 mm implants to make perforations. Their results suggested that both techniques showed canine retraction at same pace and MOP being minimally invasive facilitated flapless procedure no post op pain and no external root resorption was seen during the orthodontic movement in CBCT analysis. Shoreibah et al^{25,26} used the modified technique of corticotomy concluded that the reduction in duration of total treatment time with no much observable changes in bone density. Lee et al¹³ evaluated the treatment outcomes of 3 different procedures including conventional orthodontics, corticotomy assisted orthodontic treatment (CAOT) and anterior segmental osteotomy for bimaxillary dentoalveolar protrusion patients in 65 patients which were divided into 3 groups and concluded that CAOT was advantageous in achieving maximum retraction in short period of time than other procedures. Coscia et al²⁷ evaluated the bone changes with CBCT during pre op and post op after CAOT in class 3 patients. They have concluded

that the mean amount of vertical bone showed no statistical significance but the horizontal bone thickness was increased on the buccal side than on lingual side.

Alfawal et al²⁸ compared piezocision and laser assisted flapless corticotomy (LAFC) using Er:YAG lasers in 36 class 2 patients for canine retractions. Their results suggested that both treatments are flapless and no statistical difference seen in between experimental and control sites regarding anchorage loss and canine rotation. But the rate of retraction of canine was significantly greater on LAFC that piezo side in the 1st and 3rd months.

Comparative studies have been done in the grafting as well. Fredrico et al²⁹ done corticotomy procedure with and without grafting in 20 patients and concluded that corticotomy combined with guided bone regeneration has the potential to increase the scope of the orthodontic treatment by allowing expansive movements beyond limit. Xiaohu Liu et al³⁰ compared the membrane fixation technique (modified technique) and non membrane fixation technique after Bio-oss placement as a grafting substitute in PAOO. Membrane fixation acted as a pouch in preserving the graft and provided superior augmentation and satisfactory regeneration. Bahammam et al³¹ compared the effectiveness of bovine derived xenograft and bioactive glass in PAOO for about 15 weeks and stated that xenograft group provided superior results over bioactive glass and conventional corticotomy technique. Viswa et al³² combined recombinant human bone morphogenetic protein (Rh BMP) along with PAOO and compared with conventional technique of PAOO without grafting. Rh BMP group showed superior properties stating that BMP-2 directly enhanced the RANKL stimulation reducing the bone mineralization which made the treatment to be faster. Francisco Munzo et al³³ used leukocyte platelet rich fibrin (L-PRF) and stated that it has accelerated wound healing, reduced the surgical pain, inflammation and infection control over 2 years thus alleviating the need for analgesics and anti inflammatory medications. Shoribah et al²⁵ performed the modified corticotomy with and without grafting in 20 patients and grafted sites showed increased bone density than the non grafted sites. Many studies have used Demineralised freeze dried bone allograft (DFDBA) as bone graft.³⁴

PAOO was also done in thin biotype patient by Leila et al³⁵ which concluded positive results improvement of soft tissues and in orthodontic treatment as well.

Systematic review done by Viwattanatipa et al³⁶ in 2017 stated that

1. Corticotomy and piezocision increased the rate of orthodontic canine retraction.
2. Corticotomy had the potential to generate 2 to 4 times greater canine retraction rate than that seen in the control.
3. Corticotomy with both buccal and palatal flap elevation could generate greater canine retraction rate

than could corticotomy with only buccal flap elevation.

4. Piezocision resulted in a canine retraction rate 1.5 to 2 times faster than that seen in the control.
5. For canine retraction into the immediate premolar extraction site, the rate of canine retraction after piezocision was almost comparable to that of corticotomy (with only buccal flap elevation).
6. Corticotomy (with a flap design avoiding marginal bone incision) or flapless piezocision did not have an adverse impact on the periodontal status, including the plaque index, probing depth, attachment levels, gingival recession, mobility scores, and alveolar crest levels or root resorption.

2. Conclusion

An interdisciplinary approach of treating the conditions has improved the wide aspect of scope and treatment success as seen in PAOO. Comparative studies enable us in knowing the superior and effective results in approaching to a procedure in this wide era of availability of different materials. Therefore a proper comparison of these study results enables the operator in better relativity to the current scenarios.

3. Conflict of Interest

The authors declare that there are no conflicts of interest in this paper.

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None.

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