DOI: 10.7860/JCDR/2014/7576.3978

Review Article

Dentistry Section

# Wilckodontics - A Novel Synergy in Time to Save Time

SIRISHA K.[1], SRINIVAS M.[2], RAVINDRANATH D.[3], PRATAP GOWD[4]

## ABSTRACT

The systematic search for improvements in orthodontic therapy is shared by several dental specalities especially periodontics. Rapid orthodontic treatment procedures are now focusing on performing Alveolar Corticotomies (ACS) shortly before the application of orthodontic forces. This method has been suggested to enhance tooth movement and, consequently, reduces orthodontic treatment time as a whole. Thus, this article attempts to review the historical perspective of these therapeutic approaches, discusses the biological reasons underlying its use, mentions its main indications and contraindications and its modifications.

**Keywords:** Alveolar corticotomies, Accelerated orthodontics, Orthodontic tooth movement

## INTRODUCTION

The term synergy refers to two or more distinct influences or agents acting together to create an affect greater than that predicted by knowing only the separate affects of the individual agents. Over last decades, this definition refines the classic relationship between orthodontic and periodontic specialities in treating patients. Interdisciplinary orthodontic tooth movement can synchronize with tissue engineering principles of periodontal regenerative surgery to create rapid orthodontic movement and overcome its side effects [1].

Orthodontic tooth movement is influenced by increased alveolar bone metabolism and bone turnover rate, which determines the quantity and quality of orthodontic tooth movement [2]. High bone turn over signifies increase in the rate of tooth movement whereas slower tooth movement was found in animals with less turn over [3,4]. The four types of surgical damage to the alveolar bone include: Osteotomy (complete cut through cortical and medullary bone), corticotomy (partial cut of cortical plate without penetrating medullary bone), ostectomy (removal of an amount of cortical and medullary bone) and corticotectomy (removal of an amount of cortex without medullary bone) [5,6].

The surgical wounding of alveolar bone potentiates tissue reorganization and healing by a way of transient burst of localized hard and soft tissue remodeling [7].

### Periodontally Accelerated Osteogenic Orthodontics (PAOO)

#### Historical review

The nature of orthodontic tooth movement needs to be revisited, for research to develop a novel treatment method combining selective alveolar decortication, alveolar augmentation and orthodontic treatment. The method of PAOO is patented by "Wilckodontics" based on the emerging concepts of Wilcko brothers [8].

Surgically asssisted orthodontic tooth movement has been used since the 1800's. In 1893, Cunningham presented "Luxation, or the immediate method in the treatment of irregular teeth" at the International Dental Congress in Chicago. Corticotomy facilitated tooth movement was first described by LC Bryan in 1893 published in the textbook by SH Guiliford. It was Henrich Kole's publication in 1959, however that set the stage for evolution of corticotomy facilitated orthodontics [9]. Kole believed that it was the continuity and thickness of the denser layer of cortical bone that offered the most resistance to tooth movement. He theorized that by disrupting the continuity of this cortical layer of bone, he was actually creating and moving blocks of bone in which teeth were embedded. He postulated this theory as "bony block movement" [10].

Bell WH and Levy BM published the first experimental study of alveolar corticotomy in 49 monkeys in 1972. They described a model of vertical interdental corticotomy that should have been considered an osteotomy, because they mobilized all dento-osseus segments [11].

Further, Duker J investigated the affect of corticotomy on tooth vitality and the marginal periodontium in beagle dogs. His results supported the idea of preserving the marginal crest bone in relation to interdental cuts. The cuts must always be left at least 2 mm short of the alveolar crestal bone level [12].

### Biomechanics of Wilckodontics

#### Regional Acceleratory Phenomenon (RAP)

Orthopedist Herald Frost, recognised that surgical wounding of osseous tissue results in striking reorganising activity adjacent to the site of injury (in osseous/ soft tissue surgery). He collectively termed this cascade of physiologic healing events –"The Regional Acceleratory Phenomenon" (RAP) [13,14]. The RAP is a local response of tissues to noxious stimuli by which tissue regenerates faster than normal in a regional regeneration/remodeling process [15]. This response varies directly in duration, size, and intensity with the magnitude of the stimulus. The duration of RAP depends on the type of tissue, and usually lasts about four months in human bone. This phenomenon causes bone healing to occur 10-50 times faster than normal bone turnover [16].

The healing phases of RAP have been studied 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 seven. This cortical bridge of woven bone is a fundamental component of RAP, providing mechanical stability of bone after injury. From day seven, the woven bone in the cortical area begins to undergo remodeling to lamellar bone, but woven bone in the medullary area undergoes resorption, which means transitory local osteopenia. It seems that medullary bone needs to be reorganized and rebuilt after establishment of the new structure of cortical bone, and to adapt to the reestablishment of cortical integrity (three weeks in rats). There is also a Systemic Acceleratory Phenomenon (SAP) of osteogenesis due to systemic release of humoral factors [16].

In human long bones,following surgical injury, RAP begins within a few days, usually peaks at 1-2 months, and may take from 6 to 24 months to subside completely [14]. RAP results in a decrease in regional bone densities (osteopenia) in healthy tissues where as the volume of bone matrix remains constant [13]. Orthodontic force application alone is a stimulant sufficient to trigger mild RAP activity.

But when tooth movement is combined with selective decortication, RAP is maximized [16,17]. However, in 2001 Wilcko WM et al., revisited the original technique of bony block movement with some modifications.He attempted two cases with severely crowded dental arches, and speculated that the dynamics of physiologic tooth movement in patients who underwent selective decortication might be due to a demineralization-remineralization process rather than bony block movement. They suggested that this process would manifest as a part of RAP that involves the alveolar bone after being exposed to injury (corticotomy) and during active tooth movement [6].

## PAOO Procedures

Modifying the balance between the resorption and opposition and there by bypassing the waiting time for the alveolar process to resorb and move the teeth farther without causing irreversible damage to periodontium has been the focus of many research projects [9,10]. The catabolic activity mediated by osteoclasts is the limiting factor in the rate of tooth movement in which periodontal ligament plays a crucial role [18]. Corticotomy-Assisted or Corticotomy-Facilitated Orthodontics (CAO) is a therapeutic procedure that helps orthodontic tooth movement by accelerated bone metabolism due to controlled surgical damage. It is considered an intermediate therapy between orthognatic surgery and conventional orthodontics [9,10].

Initially, vertical cortical scaring incisions were performed interproximallly and extending well beyond the dental apices. A sub apical horizontal osteotomy was done at 10 mm supra apical to the anterior teeth penetrating the buccal and lingual cortical plates and in the post medullary bone. This connects vertical incisions to facilitate what was characterised as “Bony Block concept” that resulted in a shorter treatment time (6-12 weeks). It is generally accepted that heavier forces must be applied in cases of “bone block” movement after corticotomy to move the tooth–bone block. Bone block movement after osteotomy creates a dynamic microenvironment similar to distraction osteogenesis, but does not show regional demineralization in medullary bone [19].

### Advantages of corticotomy

Corticotomy has many advantages compared with osteotomy. It prevents injury of the periodontium, pocket formation, prevents tooth devitalization and shortens treatment time. The nutritive function of the bone is maintained through the spongiosa, although the bone is exposed, avoiding the possibility of bone aseptic necrosis [9,10].

### Indications:

The CAO procedure solves some clinical situations that are difficult to treat by conventional orthodontic means, like resolution of tooth crowding, canine retraction after premolar extraction, eruption of impacted tooth, promotes slow orthodontic expansion, molar intrusion for prosthodontic reasons, molar intrusion with open bite correction, and enhancement of post orthodontic stability [20].

# CLINICAL CASE REPORTS

Generson RM et al., described rapid orthodontic treatment for open bite malocclusion in 1978 using alveolar decortication without subapical osteotomy [17]. This modified surgical procedure was reported in 1991 and was referred to as corticotomy faciliated orthodontics [18].

In 1991, Suya H reported surgical orthodontic treatment of 395 adult japanese patients with an improved surgical procedure that he referred to as corticotomy facilitated orthodontics. Suya’s surgical technique differed from Kole’s with the substitution of supraapical corticoomy cut in place of horizontal osteotomy cut beyond the apices of the teeth. Suya H contrasted this technique with conventional orthodontics. This technique was found to be less painful, producing less root resorption and relapse. He recommended completing the major active tooth movements in 3-4 months [18]. In 1986, Anholm L et al., reported treatment of severe malocclusion using corticotomy facilitated orthodontics [19].

## Modifications of CAO procedure

### Concept of Compression Osteogenesis (CO)

Molars intrusion requires some corticotectomy, depending on the amount of intrusion. Miniplates and microscrews are used with buccal and palatal elastic traction of 100-150 grams per side, observing the results after two months (3 mm of intrusion). This procedure may be designated as CO instead of CAO, because the bone–tooth block is only supported by medullary bone and overlying mucosa.

However, cortical palatal plates may limit this movement at the level of the incisor apices, even when premolar extractions have been done. A horizontal palatal corticotectomy behind the upper incisor and a horizontal labial corticotomy may resolve this situation (two stages). In this situation, there is a block of bone (pedicled with medullary bone) that must be moved rather than moving teeth through the bone, which is another model of the CO procedure. Thus, a heavier orthopedic force of 500-900 grams must be applied by anchorage of palatal bone plates. This concept of CO uses similar biological fundamentals to CAO, but with corticotectomy instead of corticotomy. Thus, movement of the bone block with included teeth in CO is larger and more unstable than movement of teeth in the weakened alveolar bone of CAO.

Stability after treatment has always been an important concern after orthodontic treatment. Thinner mandibular cortices are a risk feature for bony dehiscence after decrowding orthodontic treatment. Techniques that increase alveolar volume with grafts may resolve this situation. Thus, where 5 mm of crowding was considered the limit for traditional orthodontics without extraction, this may be extended to 10-12 mm without risk of dehiscence. Retention and stability with CAO are better that with conventional orthodontics. However, there have been no long-term prospective longitudinal studies supporting these initial results.

Kanno T et al., described a CO procedure used to treat a case of severe open bite, moving the upper posterior bone–tooth segments 7 mm in a superior position. They used anchor plates and elastics three weeks after surgical intervention in two stages. Satisfactory results were obtained after six months of orthodontic treatment [21].

Dibart S et al., described a tunnel approach with piezoelectric bone cuts. Several vertical incisions are distributed on the attached gingiva through piezo-electric vertical corticotomies. The tunneling approach allows placement of the bone graft. A case of mild crowding was solved within 17 weeks of active treatment with this approach [22].

## Alveolar Corticotomies (ACS)

ACS are defined as a surgical intervention limited to the cortical portion of the alveolar bone. Whereas in osteotomies both cortical and trabecular bone material is removed in considerable quantities. In ACS the incision must pierce the cortical layer, and at the same time, penetrate into the bone marrow only minimally [23].

Another example of this growing interest can be illustrated by an event that took place in the last Meeting of the American Association of Orthodontists, held in Washington in May 2010: The highest award for research in orthodontics in the United States and Canada (the Milo Hellman Award) was bestowed on a study that assessed the mechanism and morphological changes in alveolar bone following ACS [24].

### Indications for the use of ACS in orthodontics

These can be grouped into three main categories: (1) to accelerate corrective orthodontic treatment, as a whole, (2) to facilitate the implementation of mechanically challenging orthodontic movements, and (3) to enhance the correction of moderate to severe skeletal malocclusions. Reports can be found that describe

the successful use of ACS in the enhanced correction of severe bimaxillary protrusion, [25] closure of complex skeletal open bites, [26] intrusions and molar uprighting combining ACS and mini-implants, [27] and optimization of treatment of patients with cleft lip and palate, [28].

### Contraindications

Recently, Wilcko WM et al., gave an objective account of scenarios where the use of ACS-orthodontics should be avoided. These include (1) patients showing any sign of active periodontal disease, (2) individuals with inadequately treated endodontic problems, (3) patients on prolonged use of corticosteroids, (4) persons under medications that slows down bone metabolism, such as bisphosphonates and NSAIDs [6].

## Novel approaches for PAOO

### Lasers

Laser assisted flapless corticotomy is a useful non-invasive procedure for reducing treatment time and damage to periodontium. It enhances the orthodontic tooth movement by reducing the cortical bone layer (resistant to bone re-sorption relative to spongious bone) following Erbium, Chromium doped Yttrium Scandium Gallium Garnet (Er-Cr: YSGG) laser irradiation, without surgical flap reflection [29].

### Monocortical tooth dislocation and ligament distraction (MTDLD) technique:

The MTDLD technique combines two different dental movements that work separately but simultaneously on opposite root surfaces. On the root surface corresponding to the direction of movement, vertical and horizontal microsurgical corticotomies are performed around each tooth root with a piezosurgical microsaw to eliminate cortical bone resistance. The immediate application of strong biomechanical forces produces rapid dislocation of the root and the cortical bone together. On the root surface opposite the direction of movement, the dislocation force produces rapid distraction of ligament fibers. During the osteogenic process that follows, application of normal orthodontic biomechanics achieves the final tooth movement [30].

Tomaso Vercellotti, Andrea Podesta et al., have developed a new surgical-orthodontic technique to maximize the rapidity of movement and prevent damage to the periodontal tissues. These goals may be achieved with a piezosurgical technique. (TV) 10-26 that permits microsurgical corticotomy around each root and the immediate application of biomechanical force. This technique avoids involvement of the periodontal tissue fibers, which is necessary in traditional orthodontic movement, thereby preventing periodontal and bone resorption. The greatest amount of dental movement occurs in approximately the first 30% of total treatment time with the MTDLD technique [31,32].

# DISCUSSION

Based on the information reviewed on wilckodontics, this article also discusses the recent views and unrevealed controversies on wilckodontics.

The upcoming controversies in different aspects of wilckodontics were focused in an assignment conducted by David P Mathews and Vincent G Kokich in 2013. They analysed the efficacy, effectiveness, and efficiency of Wilckodontics in the following dimensions:

The role of ACS in acceleration of tooth movement:

The effects of ACS on the acceleration of tooth movement was documented in rats [24, 33-37], dogs, cats [38] and humans [5, 39-43] based on split mouth study designs. The outcome of these experiments show that the rate of tooth movement is doubled on the corticotomy treated site (about 1mm/month).

Mechanism of corticotomy produced accelerated tooth movement:

Dr. Wilcko brothers believed that the rate of tooth movement is primarily due to localized demineralization-remineralisation processs that occurs in the cancellous bone surrounding the tooth socket and secondarily due to alterations within the periodontal ligament. This was verified using surface computed tomography scan. Many studies [36,38,44,45] documenting the histologic and physiologic effects of initial stages of tooth movement have shown that hyalinization of the periodontal ligament occurs on the pressure side. This hyaline formed inhibits bone resorption in the periodontal ligament. Further experiments in dogs have shown that hyaline is gradually removed from periodontal ligament by macrophages that differentiate from mesenchymal cells that migrate to that area [36]. This takes upto four weeks. During this initial period no tooth movement occurs [36]. So, during alveolar corticoytomy, RAP accelerates the appearance of macrophages that remove hyaline as early as one week after initiation of orthodontic forces [36,38]. This early hyaline removal allows early bone resorption and rapid tooth movement.

## Duration of RAP after corticotomy:

Studies [37] comparing the rate of tooth movement showed that the tooth movement peaked at 22-25 days and then decelerated. During this three week period, corticotomy facilitated side moved twice than the control side. Similar results were obtained in a study [41] conducted in adults to retract maxillary canines following premolar extractions. Based on the outcome of these studies the length of RAP was probably four months, after which the rate of tooth movement returns to normal.

## Effect of corticotomy on the treatment time for adults:

Reviews [6,39,40,43,46-50] on corticotomy claim that it shortens the treatment time. However, one cannot measure treatment time without measuring treatment quality. The American Board of orthodontics has developed a detailed grading system to assess the quality of orthodontic treatment [51]. Yet to date there are no RCT's focusing on this aspect of corticotomy.

## Role of grafting of alveolus in enhancing orthodontic treatment

In support of wilcko's concept, published data [5,39,43,48] claims that bone grafting enhances the stability of orthodontic treatment results. Some cases report a greater volume of bone in Computed tomographic Scans [5]. However is the new bone incorporated into native cortical –plate, or is it fibroosseous material encapsulated on the outside of the cortical plate was evaluated. The scans suggest that it is a fibroosseous encapsulation [5]. Moreover a distinct disadvantage of this procedure is the additional cost, invasive nature and morbidity associated with the surgery [39,52].

# CONCLUSION

Wilckodontics the new synergy of orthodontics interplaying with periodontics on the same bony platform has made adult orthodontics a reality. This credit goes to the regional accelerated phenomenon due to transient osteopenia. This tissue response elicited was proved to be beneficial in the treatment of clinical situations like decrowding, molar intrusion etc. So, ACS is effective at accelerating tooth movement. But it is inappropriate to conclude that it reduces orthodontic treatment time without assessing treatment quality. The significance of bone grafting along with corticotomy is yet to be evaluated in RCT's. However, review of literature could not reveal any established guidelines for selection of osteotomy or corticotomy though the later proved to be advantageous. Thus, understanding the biomechanics of bone remodelling may increase the clinical applications of corticotomy facilitated orthodontics with or without alveolar augmentation. Wilckodontics can be an attractive treatment option and be a "win-win" situation for both the doctor and patient if research attempts to relieve this clinical dilemma.

# REFERENCES

[1] Little RM. Stability and relapse of dental arch alignment In Burstone CJ, Nanda R

(eds): Retention and stability in Orthodontics. Philadelphia, Saunders; 1993: 97-106.
[2] Verna C, Dalstra. M, Melsen B. The rate and the type of orthodontic tooth movement is influenced by bone turnover in a rat model. *Eur J Orthod.* 2000; 22: 343-52.
[3] Midgett RJ, Shaye R, Fruge JF Jr. The effect of altered bone metabolism on orthodontic tooth movement. *Am J Orthod.* 1981; 80: 256-62.
[4] Engström C, Granström G, Thilander B. Effect of orthodontic force on periodontal tissue metabolism. A histologic and biochemical study in normal and hypocalcemic young rats. *Am J Orthod Dentofacial Orthop.* 1988; 93:486-95.
[5] Wilcko MT, Wilcko WM, Pulver JJ, Bissada NF, Bouquot JE. Accelerated osteogenic orthodontics technique: a 1-stage surgically facilitated rapid orthodontic technique with alveolar augmentation. *J Oral Maxillofac Surg.* 2009; 67: 2149-59.
[6] Wilcko WM, Wilcko T, Bouquot JE, Ferguson DJ. Rapid orthodontics with alveolar reshaping: two case reports of decrowding. *Int J Periodont Restorat Dent.* 2001; 21: 9–19.
[7] Shih MS, Norrdin RW. Regional accerelation of remodeling during healing of bone defects in beagles of various ages. *Bone.* 1985; 5: 377-79.
[8] Hajji SS. The influence of accelerated osteogenic response on mandibular decrowding [thesis]. St Louis: St Louis Univ; 2000.
[9] Köle H. Surgical operations of the alveolar ridge to correct occlusal abnormalities. *Oral Surg Oral Med Oral Pathol.* 1959; 12: 515-29.
[10] Kole H. Surgical operations on the alveolar ridge to correct occlusal abnormalities. *Oral Surg Oral Med Oral Pathol.* 1959; 12: 413-20.
[11] Bell WH, Levy BM. Revascularization and bone healing after maxillary corticotomies. *J Oral Surg.* 1972; 30: 640–8.
[12] Duker J. Experimental animal research into segmental alveolar movement after corticotomy. *J Maxillofac Surg.* 1975; 3: 81–4.
[13] Frost MH. The biology of fracture healing: An overview for clinicians Part I. *Clin Ortho.* 1989; 248: 283-93.
[14] Frost MH. The biology of fracture healing: An overview for clinicians Part II. *Clin Ortho.* 1989; 248: 294-309.
[15] Frost HM. The regional acceleratory phenomenon: a review. *Henry Ford Hosp Med J.* 1983; 31:3–9.
[16] Schilling T, Müller M, Minne HW, Ziegler R. Influence of inflammation-mediated osteopenia on the regional acceleratory phenomenon and the systemic acceleratory phenomenon during healing of a bone defect in the rat. *Calcif Tissue Int.* 1998; 63: 160–6.
[17] Generson RM, Porter JM, Stratigos GT. Combined surgical and orthodontic management of anterior open bite using corticotomy. *J Oral Surg.* 1978; 36: 216–9.
[18] Suya H. Corticotomy in orthodontics. In Hosl E, Baldauf A (eds), Mechanical and biological basis in orthodontic therapy. Germany: Huthig Buch Verlag; 1991: 207-26.
[19] Anholm L, Crites D, Hoff R, Rathbun E. Corticotomy – facilitated Orthodontics. *Calif Dent Assoc J.* 1986; 7: 8-11.
[20] Oliveira DD, Franco B, Villamarin R. Alveolar corticotomies in orthodontics: indications and effects on tooth movement. *Dent Press J Orthod.* 2010; 15: 144-57.
[21] Kanno T, Mitsugi M, Furuki Y, Kozato S, Ayasaka N, Mori H. Corticotomy and compression osteogenesis in the posterior maxilla for treating severe anterior open bite. *Int J Oral Maxillofac Surg.* 2007; 36: 354-7.
[22] Dibart S, Sebaoun JD, Surmenian J. Piezocision: a minimally invasive, periodontally accelerated orthodontic tooth movement procedure. *Compend Contin Educ Dent.* 2009; 30: 342–50.
[23] Chung KR, Kim SH, Lee BS. Speedy surgical-orthodontic treatment with temporary anchorage devices as an alternative to orthognathic surgery. *Am J Orthod Dentofacial Orthop.* 2009; 139: 787–98.
[24] Baloul SS. Mechanism of action and morphological changes in the alveolar bone in response to selective alveolar decortication facilitated tooth movement. *Am J Orthod Dentofacial Orthop.* 2011;139 (Supp) S83-101.
[25] Lino S, Sakoda S, Miyawaki S. An adult bimaxillary protrusion treated with corticotomy-facilitated orthodontics and titanium miniplates. *Angle Orthod.* 2006; 76: 1074-82.
[26] Akay MC, Aras A, Günbay T, Akyalçin S, Koyuncue BO. Enhanced effect of combined treatment with corticotomy and skeletal anchorage in open bite correction. *J Oral Maxillofac Surg.* 2009; 67:563-9.
[27] Kim SH, Kook YA, Jeong DM, Lee W, Chung KR, Nelson G. Clinical application of accelerated osteogenic orthodontics and partially osseointegrated mini-implants for minor tooth movement. *Am J Dentofacial Orthop.* 2009; 136: 431-9.
[28] Yen SLK, Yamashita DD, Kim TH, Baek HS, Gross J. Closure of an unusually large palatal fistula in a cleft patient by bony transport and corticotomy-assisted expansion. *J Oral Maxillofac Surg.* 2003; 61: 1346-50.
[29] Massoud Seifi, Farnaz Younessian, Nazila Ameli. The innovated laser assisted flapless corticotomy to enhance orthodontic tooth movement. *J Lasers in Med Sci.* 2012; 3; 1-12.
[30] Tomaso Vercellotti, Andrea Podesta. Orthodontic oicrosurgery: A new surgically guided technique for dental movement. *Int J Periodontics Restorative Dent.* 2007; 27: 325-31.
[31] Vercellotti T, Nevins ML, Kim DM, et al. Osseous response following resective therapy with piezosurgery. *Int J Periodontics Restorative Dent.* 2005; 25: 543-49.
[32] Chiriac G, Herten M, Schwarz F, Rothamel D, Becker J. Autogenous bonechips: Influence of a new piezoelectric device (Piezosurgery) on chip morphology, cell viability and differentiation. *J Clin Periodontol.* 2005; 32: 994-99.
[33] Sebaoun JD, Kantarci A, Turner JW, Carvalho RS, Van Dyke TEW, Ferguson DJ. Modeling of trabecular bone and lamina dura following selective alveolar decortication in rats. *J Periodontol.* 2008; 79: 1679-88.
[34] Lee W, Karapetyan G, Moats R, Yamashita DD, Moon HB, FergusonDJ, et al. Corticotomy-/osteotomy-assisted toothmovement micro CTs differ. *J Dent Res.* 2008; 861-7.
[35] Wang L, Lee W, Lei DL, Liu YP, Yamashita DD, Yen SL. Tissue responses in corticotomy- and osteotomy-assisted tooth movementsin rats: histology and immunostaining. *Am J Orthod Dentofacial Orthop.* 2009; 136: 770. e1-11.
[36] Iino S, Sakoda S, Ito G, Nishimori T, Ikeda T, Miyawaki S. Acceleration of orthodontic tooth movement by alveolar corticotomyin the dog. *Am J Orthod Dentofacial Orthop.* 2007; 131: 448. e1-8.
[37] Sanjideh PA, Rossouw PE, Campbell PM, Opperman LA,Buschang PH. Tooth movements in foxhounds after one ortwo alveolar corticotomies. *Eur J Orthod.* 2010; 32: 106-13.
[38] Kim SJ, Park YG, Kang SG. Effects of corticision on paradental remodelingin orthodontic tooth movement. *Angle Orthod.* 2009; 79: 284-91.
[39] Murphy KG, Wilcko MT, Wilcko WM, Ferguson DJ. Periodontalaccelerated osteogenic orthodontics: a description of the surgicaltechnique. *J Oral Maxillofac Surg.* 2009; 67: 2160-6.
[40] Kim SH, Kim I, Jeong DM, Zadeh H. Corticotomy-assisted decompensationfor augmentation of the mandibular anterior ridge. *Am J Orthod Dentofacial Orthop.* 2011; 140: 720-31.
[41] Aboul-Ela SM, El-Beialy AR, El-Sayed KM, Selim EM, El-Mangoury NH, Mostafa YA. Miniscrew implant-supported maxillary canine retraction with and without corticotomy-facilitatedorthodontics. *Am J Orthod Dentofacial Orthop.* 2011; 139: 252-9.
[42] Long H, Pyakurel U, Wang Y, Liao L, Zhou Y, Lai W. Interventionsfor accelerating orthodontic tooth movement: a systematic review. *Angle Orthod.* 2013; 83: 164-71.
[43] Wilcko MT, Wilcko WM, Bissada NF. An evidence-based analysis ofperiodontally accelerated orthodontic and osteogenic techniques: a synthesis of scientific perspectives. *Semin Orthod.* 2008; 14: 305-16.
[44] Von Bohl M, Maltha J, Von den Hoff H, Kuijpers-Jagtman AM.Changes in the periodontal ligament after experimental tooth movement using high and low continuous forces in beagledogs. *Angle Orthod.* 2004; 74: 16-25.
[45] Von Bohl M, Maltha JC, Von Den Hoff JW, Kuijpers-Jagtman AM. Focal hyalinization during experimental toothmovement in beagle dogs. *Am J Orthod Dentofacial Orthop.* 2004; 125: 615-23.
[46] Fischer TJ. Orthodontic treatment acceleration withcorticotomy-assisted exposure of palatally impacted canines: a preliminary study. *Angle Orthod.* 2007; 77: 417-20.
[47] Nowzari H, Yorita FK, Chang HC. Periodontally accelerated osteogenicorthodontics combined with autogenous bone grafting. *Compend Contin Educ Dent.* 2008; 29: 200-6.
[48] Hassan AH, Al-Fraidi AA, Al-Saeed SH. ... Corticotomy-assisted orthodontic treatment: a review. *Open Dent J.* 2010; 4: 159-64.
[49] AlGhamdi AST. Corticotomy facilitated orthodontics: review of a technique. *Saudi Dent J.* 2010; 22: 1-5.
[50] Einy S, Horwitz J, Aizenbud D. Wilckodontics—an alternative adult orthodontic treatment method: rational and application. *Alpha Omegan.* 2011;104:102-11.
[51] Casko J, Vaden J, Kokich V. American Board of Orthodonticsobjective grading system for dental casts and panoramic radiographs. *Am J Orthod Dentofacial Orthop.* 1998; 114: 589-99.
[52] Cassetta M, Di Carlo S, Giansanti M, Pompa V, Barbato E. The impactof osteotomy technique for corticotomy-assisted orthodontic treatment (CAOT) on oral health-related quality of life. *Eur Rev Med Pharmacol Sci.* 2012; 16: 1735-40.

**PARTICULARS OF CONTRIBUTORS:**
1. Reader, Department of Periodontics, Sibar Institute of Dental Sciences, Guntur, Andhara Pradesh, India.
2. Professor, Department of Periodontics, Sibar Institute of Dental Sciences, Guntur, Andhara Pradesh, India.
3. Professor, Department of Periodontics, Sibar Institute of Dental Sciences, Guntur, Andhara Pradesh, India.
4. Assistant Professor, Department of Pedodontics and Preventive Dentistry, Sibar Institute of Dental Sciences, Guntur, Andhara Pradesh, India.

**NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:**
Dr. Pratap Gowd MJS,
Assistant Professor, Department of Pedodontics and Preventive Dentistry,
Sibar Institute of Dental Sciences, Guntur-522509, Andhra Pradesh, India.
Phone: 09704288682, E-mail: prathapmjs@gmail.com

**FINANCIAL OR OTHER COMPETING INTERESTS:** None.

Date of Submission: **Sep 05, 2013**
Date of Peer Review: **Nov 14, 2013**
Date of Acceptance: **Dec 03, 2013**
Date of Publishing: **Jan 12, 2014**