

Dento-alveolar distraction (DAD): A rapid orthodontic outlook

*¹ Dr. Dilip Kumar N, ² Dr. Nasser Tayi Al-Mutairi, ³ Abdulkarim Ahmed M Alqarni', ⁴ Dr. Hussam Muneer Alqahtani

¹ Reader, Department of Orthodontics, College of Dental Sciences & Hospital Davengere, Karnataka, India

² Resident Dentist, Armed Forces Hospital, Najran, KSA

³ Resident Dentist, Armed Forces Hospital, Hafar Al Batin, KSA

⁴ Resident Dentist, Ministry of Health, Bisha, KSA

Abstract

In this modern era, a variety of orthodontic cases generally presents with a deficiency of space and little bit of crowding. In the past few years, non-extraction measures that use extraoral or intraoral distalization techniques (along with mini screw and orthodontic implant retained vitalization means) have turn out to be very popular. Nevertheless, patients often have need of treatment based on tooth extraction. Various clinical approaches have been suggested in the literature that lessens the overall orthodontic treatment time. Though, distraction osteogenesis is usually employed in different skeletal bones, and usage of this procedure in craniofacial diseases and with dentoalveolar anomalies has really become eminent in recent time. In most of the clinical situations where patient generally need orthodontic correction have one desire that is off course nothing but "Speedy Treatment". So, for the overall reduction of time taken in orthodontic treatment, several ideologies have been introduced by pioneer workers. Amongst them, one of the most recent procedures is Dento-Alveolar Distraction "DAD technique". It has been considered as one of the most accepted practice in orthopaedic surgery as an successful way of bone lengthening in rectification of skeletal defect and in restoring large diaphyseal defects. Here in this paper authors have genuinely attempted to explore the basic concept and idea of dentoalveolar distraction in rapid distalization of canine in orthodontic cases those require extraction of first premolar extraction.

Keywords: canine retraction, dentoalveolar distraction, distraction osteogenesis, distractors

Introduction

Almost every orthodontic patient has some or other form of dental crowding. Even though treatment without dental extraction has become accepted in the last few decades [1]. Codivilla was the first one to perform Distraction osteogenesis in 1905 [2]. Later on it was popularized in Russia by clinical and research studies by Illizarov [3]. Guerrero and MaCarthy and co-workers in 1992 conducted distraction osteogenesis in human mandible [4-5]. After that it has been employed to different bones of craniofacial skeleton in rectifying skeletal class II and Class III anomalies. The general concept to orthodontic tooth movement and rapid canine retraction by distraction of alveolar bone was originally described by Liou [6-8]. Literature has well evidenced that many attempts have been made in last few decades to shorten orthodontic treatment time. Proffit *et al* assured that the joint efforts of orthopaedic traction and corticotomy could be helpful for anterior retraction and posterior intrusion, and such procedures may lessen the orthodontic treatment time. The surgical method of corticomy-assisted orthodontics usually involves palatal and vestibular mucosal incisions and corticotomies [9-11]. In Dento-Alveolar Distraction, mucosal incisions and osteotomies are done only on the vestibular side of the alveolar bone, and the gingival margin, palatal mucosa, and palatal bone stay undamaged, therefore maintaining sufficient blood supply for the transfer of dentoalveolar section that includes the canine. Dental professionals including orthodontists have always struggled hard for inventing latest techniques to cut down the overall treatment time. Canine distraction was firstly introduced as a treatment of choice to reduce the duration of the orthodontic treatment and therefore avoiding unnecessary strain on the

anchor unit. Hence, under standard conditions, a predictable treatment with fixed appliances is appeared to last for 20 to 24 months. This time duration of the orthodontic treatment is one of the main concerns that orthodontic patients criticize about the most. And this mostly happened in the cases of adult patients. So as to minimize all these dilemmas, a system of rapid canine retraction in which the concepts of distraction osteogenesis are utilized, has been developed. This is called dentoalveolar distraction (DAD). Distraction device used by Liou and Huang is a custom-made distraction device [12]. Some of the pioneer workers like Sukurica *et al* customized the conservative Hyrax expander for distraction [13]. The distractor utilized in their study was approximately related to the distractor used by Kisnisci *et al* which is commercially available in the market [14]. Such distractors are high efficient and usually offer improved control over the distracted teeth when compared to the other distractors used formerly.

As we have seen in various orthodontic case reports that almost all orthodontics treatment depend on biological tooth movements, because of this tooth movement may be accomplished. Literature showed a number of pioneering techniques those known to accelerate orthodontic tooth movement. Some of the prominent ones are; low-level laser therapy, pulsed electromagnetic fields, electrical currents, corticotomy which is defined as any intentional surgical injury to cortical bone. Distraction is carried out only after the root formation is complete. It has been sought that relative effects of distraction on incompletely formed root is not researched well. This technique does not exert much load on the periodontal ligament. The new bone is formed by stretching of

the callus in the osteotomy or corticotomy gap with distraction device.

Historical Background

In the beginning of twentieth century, Alessandro Codivilla was amongst the first pioneers who introduced process of distraction osteogenesis for lengthening of the lower limbs [15]. Conversely, at that time, it did not that much attention and acceptance till the time Gavril Ilizarov, invented a technique for repairing complex fractures or nonunion of the long bones. Later on Guerrero [16] and McCarthy *et al* [17] conducted distraction osteogenesis in human mandible. It is only after their invention it has been used in various bones of craniofacial skeleton. Afterwards, Liou and Huang put forwarded the idea of distraction osteogenesis in tooth movement in the form of periodontal ligament osteogenesis. They concluded that the procedure during tooth movement is usually induced by orthodontic forces exactly similar to that of the midpalatal suture during rapid palatal expansion performed for crossbite correction. This particular procedure has been called dental distraction (DD) [18]. Kismisci *et al* finally stated that dentoalveolar distraction is based on osteotomies around the teeth, to move the segment of bone having the canines on distal side [19]. Iseri *et al* used such a similar approach to move canines distally 1 mm per day in 8 to 14 days. Since it depends on distraction osteogenesis, dentoalveolar distraction has higher expectations to tackle larger potential for producing bone compared to periodontal distraction [20]. This is due to surgical procedure does not depend on the stretching and widening of the periodontal ligament, therefore prevents overloading and force concentration in the periodontal tissues.

Histological Overview

Dentoalveolar distraction is generally characterized by gradual and controlled dislocation of a bone segment that can be obtained with the use of force vectors in desired directions without extensive surgical interventions [21]. From histological perspective distraction exhibits 3 elementary sequential phases [22]. The latency phase which is the period between the surgical osteotomy and the beginning of traction, during which soft callus is formed. It is expressed between 0 and 7 days and coincides with the initial events of the normal bone repair process. The distraction phase in which is the slow and gradual traction force is applied to the transport bone segment, and the formation of new immature woven and parallel-fibered bone commences. This phase usually lasts 1 to 2 weeks, and the traction modifies the normal development of the regeneration process. The consolidation phase begins after the desired correction has been achieved; this period allows for maturation of the regenerate and corticalization of the newly formed bone [23].

Construction Philosophy for Distractor

DAD is indicated in several clinical conditions like in patients with compliance problems, older adolescent and adult patients with moderate or severe crowding, adult Class II, Division 1 patients, bimaxillary dental protrusion patients, orthognathic surgery patients needing dental decompensation, patients with root shape malformations, short roots, and periodontal problems, patients with ankylosed teeth [20]. A custom-made, rigid, tooth-borne, intraoral distraction device may be constructed and used in the DAD patients (Fig 1a-1c). This tool

is comprised up of stainless steel with one distraction screw, two guidance bars, and a screw to trigger the distractor by turning the screw clockwise. The distractoion device could be made from a conservative Hyrax expander [24-25]. It must should be opened according to the number of millimetres that canines have to be distalized, plus at 2 mm. If at all possible, a 13 mm screw must be utilized. One of the rods of the Hyrax is rounded off and the sharp edges are then removed [25]. Appropriate polishing is compulsory, in order to guarantee better patient comfort. The original arrow on the screw have to be pointing in the direction of occlusion to ease opening and prevent forces from moving the distractor during the opening procedure [26]. Hence, as activations will be done in the reverse direction of the arrow, it declines the probability that the device be displaced. The distractor may be then stacked but make sure that the screw is totally closed and opened.

Modifications of Distractor

Palatal distractor: Made from a Hyrax screw without any clipping. Just turning it 90 degrees allows it to be used for retraction [27]. Recommended for cases where the two canines are initially proclined as it enables moving both teeth into the alveolar process.

Unilateral palatal distractor: Identical to the device advocated by Faber and described above, but positioned via the palate. It is suitable for canines in any position when the goal is to prevent buccal inclination. (Fig2 and Fig 3) [27].



Fig 1a: Custom-made canine distractors

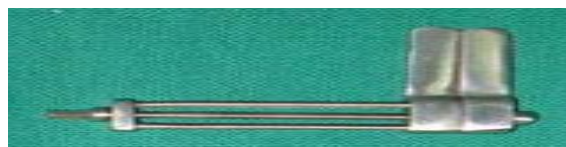


Fig 1b: Custom-made canine distractors



Fig 1c: Custom-made canine distractors



Fig 2: Bilateral Distractor



Fig 3: Unilateral Distractor

Surgical Protocols and Device Activation

It was surgical procedure was firstly explained by Kisnisci and co workers [19]. It is generally performed on the patient under local anaesthesia, many a times supplemented with sedation. Mucosal incision in horizontal direction was initiated exactly parallel to the gingival margin of the canine and the premolar outside the depth of the adjacent vestibule. Cortical holes are made in the alveolar bone with a small, round, carbide from the apex. A thin, tapered, fissure bur can be used to connect the holes around the root. Fine osteotomes are advanced in the coronal direction. The first premolar is then extracted and the buccal bone is removed between the outlined bone cut at the distal canine region anteriorly and the second premolar posteriorly. Larger osteotomes are generally utilized to completely mobilize the related alveolar section that comprised the canine by fracturing the neighbouring spongy bone about its root off the palatal cortex. The buccal and apical bone via the extraction socket and the probable bony obstructions at the buccal aspect that could be faced during the distraction procedure must be removed between the canine and the second premolar, thus preserving palatal or lingual cortical shelves. The palatal shelf ought to be preserved, but the apical bone close to the sinus wall has to be removed, leaving the sinus membrane undamaged to avoid interferences during the active distraction procedure. The transport dentoalveolar section that comprises the canine also includes the buccal cortex and the basic spongy bone that covers the canine root, leaving an intact lingual or palatal cortical plate and the bone about the apex of the canine. The incision must be congested with absorbable sutures, and an antibiotic and a nonsteroidal anti-inflammatory drug should be prescribed for 5 days [20-26]. Distraction may be done 3 days soon after surgery. Kisnisci has suggested activating the distractor two times per day, in the morning and in the evening, for a total of 0.8 mm per day. When the canine retraction is completed, fixed orthodontic appliance action must be started, it is also advised that the distracted canine and the first molar should be consolidate and kept at least 3 months after the DAD procedure [19].

Discussion

Because, the tooth movement in rapid canine distalization usually does not rely upon the periodontal ligament; therefore the speed of tooth movement is 0.9 mm/day. This is quite high than the other tooth movement of 1.15 to 1.35 mm/month. When evaluated with other conventional methods, in rapid canine distalization utilizing the rule of distraction is useful because it necessitates less treatment time, visits as well as lesser known complications. Given that extent of orthodontic

treatment is a time bound phenomenon, rapid canine distraction may be thought in patients seeking speedy completion of Orthodontic treatment procedures. Distraction osteogenesis for rapid orthodontic tooth movement is a hopeful procedure in terms of treatment period is considered. The term physiological tooth movement denotes, principally, the minor tipping of the tooth in its socket and, secondarily, the transformations in tooth position that take place during and after tooth eruption [21]. Liou *et al* showed in adult beagles, that the best time to begin the tooth movement was right away after the distraction, when the edentulous space was still fibrous and the bone configuration was just begun; they also advised that the tooth movement must be started when the osteogenic movement which was triggered by the distraction procedure was active, the new bone was still fibrous, and the trabeculae were not well formed [22]. In actual fact, there is fundamentally no big discrepancy among the tissue reactions which are identified in the physiological tooth movement and those which are seen in the orthodontic tooth movement the ideology of distraction osteogenesis has been utilized for the reason of canine retraction just to get rapid tooth movement. But this particular procedure where the canine is moved down with its dentoalveolar section is an inventive and produces quicker tooth movement. Alternatively, with the custom-made, rigid, tooth-borne distractor, canine retraction happened at a rate of 0.8 mm per day. Whole canine retraction was feasible within 7 to 15 days. This is the speediest movement of a tooth as presented in the literature [23-27].

Anchorage loss is clinically irrelevant because the duration of canine retraction is too small for movement of molar. The average sagittal and vertical anchorage losses were 0.19 mm and 0.51 mm, correspondingly, during rapid irrelevant amount of extrusion of the distraction of the canines [24]. That's why, vertical anchorage loss of the maxillary first molars, particularly in patients with open bite or propensity to open bite must be measured by means of DAD technique [28-30]. With the DAD procedure, the anchorage teeth may endure the retraction forces with no anchorage loss and devoid of any clinical or radiographical confirmation of the complications, for example root fracture and soft tissue dehiscence.

Conclusion

The DAD procedure decreases the orthodontic treatment duration by 6 to 9 months in the patients who require teeth extraction, with no requirement for extraoral or intraoral anchorage devices and with no adverse short-term complications in the periodontal tissues and in the surrounding structures. Teeth with anatomic deformities, periodontal dilemmas, or ankylosed teeth will be promoted from this technique. The dentoalveolar distraction procedure is a novel technique that lessen downs overall orthodontic treatment time by nearly 50%, with no adverse effects on surrounding structures. Along with the canine retraction, dentoalveolar distraction technique could be used in the cases of ankylosed teeth, molar intrusion, and maxillary expansion and seems to be the forefront of accelerated orthodontics.

References

1. Vig P, Weintraub JA, Brown C, Kowalski CJ. Duration of orthodontic treatment with and without extractions. *Am J Orthod Dentofacial Orthop.* 1990; 97:45-51.

2. Codivilla A. On the means of lengthening, in the lower limbs, the muscles and tissue which are shortened through deformity. *Am J Orthop Surg.* 1905; 2:353.
3. Ilizarov GA. The tension-stress effect on the genesis and growth of tissues part I. The influence of stability of fixation and soft tissue preservation. *Clin Orthop Relat Res.* 1989; 238:249-281.
4. Guerrero CA, Bell WH, Contasti GI, Rodriguez AM. Mandibular widening by intraoral distraction osteogenesis. *British journal of oral and Maxillofacial surgery.* 1997; 35:383-392.
5. McCarthy JG, Schreiber J, Karp N, Thorne CH, Grayson H. Lengthening the human mandible by gradual distraction. *Plast Reconstr Surg.* 1992; 89:1-10.
6. Liou EJW, Huang CS. Rapid canine retraction through distraction of the periodontal ligament. *Am J Orthod Dentofacial Orthop.* 1998; 114:372-382.
7. Liou EJW, Huang CS. Rapid canine retraction using distraction of the periodontal ligament. *Am J Orthod Dentofacial Orthop.* 1998; 114:372-82.
8. Liou EJW, Figueroa AA, Polley JW. Rapid orthodontic tooth movement into newly distracted bone after mandibular distraction osteogenesis in a canine model. *Am J Orthod Dentofacial Orthop.* 2000; 117:391-398.
9. Liou EJW, Huang CS. Rapid canine retraction through distraction of the periodontal ligament. *Am J Orthod Dentofacial Orthop.* 1998; 114:372-82.
10. Proffit WR, Fields HW: Fixed and removable appliances, in Proffit WR, Fields HW (eds): *Contemporary Orthodontics* (ed 2). St Louis, MO, Mosby-Year Book, 1993; pp. 317-373
11. Reitan K. Biomechanical principles and reactions, in Graber TM, Swain BF (eds): *Orthodontics: Current Principles and Techniques.* St Louis, MO, CV Mosby, 1985; pp. 101-192
12. Liou EJW, Huang CS. Rapid canine retraction through distraction of the periodontal ligament. *Am J Orthod Dentofacial Orthop.* 1998; 114:372-82.
13. Sukurica Y, Karaman A, Gürel HG, Dolanmaz D. Rapid canine distalization through segmental alveolar distraction osteogenesis. *Angle Orthod.* 2007; 77(2):226-36.
14. Kisnisci RS, Iseri H, Tuz HH, Altug AT. Dentoalveolar distraction osteogenesis for rapid orthodontic canine retraction. *J Oral Maxillofac Surg.* 2002; 60:389-94.
15. Codivilla A. On the means of lengthening, in the lower limbs, the muscles and tissue which are shortened through deformity. *Am J Orthop Surg.* 1905; 2:353.
16. Guerrero CA, Bell WH, Contasti GI, Rodriguez AM. Mandibular widening by intraoral distraction osteogenesis. *Br J Oral Maxillofac Surg.* 1997; 35(6):383-92.
17. McCarthy JG, Schreiber J, Karp N, Thorne CH, Grayson H. Lengthening the human mandible by gradual distraction. *Plast Reconstr Surg.* 1992; 89:1-10.
18. Liou EJ, Huang CS. Rapid canine retraction through distraction of the periodontal ligament. *Am J Orthod Dentofacial Orthop.* 1998 Oct; 114(4):372-82.
19. Kisnisci RS, Iseri H, Tuz HH, Altug AT. Dentoalveolar distraction osteogenesis for rapid orthodontic canine retraction. *J Oral Maxillofac Surg.* 2002; 60:389-94.
20. Cruz DR, Kohara EK, Ribeiro MS, Wetter NU. Effects of lowintensity laser therapy on the orthodontic movement velocity of human teeth: a preliminary study. *Lasers Surg Med.* 2004; 35:117-120.
21. Reitan K. The tissue behavior during orthodontic tooth movement. *Am J Orthod.* 1960; 46:881-900.
22. Liou EJW, Figueroa AA, Polley JW. Rapid orthodontic tooth movement into the newly distracted bone after mandibular distraction osteogenesis in a canine model. *Am J Orthod Dentofacial Orthop* 2000; 117:391-98.
23. Showkatbakhsh R, Jamilian A, Showkatbakhsh M. The effect of pulsed electromagnetic fields on the acceleration of tooth movement. *World J Orthod.* 2010; 11:e52-e56.
24. Kim DH, Park YG, Kang SG. The effects of electrical current from a micro-electrical device on tooth movement. *Korean J Orthod.* 2008; 38:337-346.
25. Block MS, Daire J, Stover J, Matthews M. Changes in the inferior alveolar nerve following mandibular lengthening in dogs by using distraction osteogenesis. *J Oral Maxillofac Surg.* 1993; 52:652-60.
26. Hoggan BR, C Sadowsky. The use of palatal rugae for the assessment of anteroposterior tooth movements. *Am J Orthod Dentofacial Orthop.* 2001; 119:482-88.
27. Iseri H, Kisnisci R, Bzizi N, Tuz H. Rapid canine retraction and orthodontic treatment with dentoalveolar distraction osteogenesis. *Am J Orthod Dentofacial Orthop.* 2005; 127:533-41.
28. Kisnisci RS, Iseri H, Tuz HH, Altug AT. Dentoalveolar distraction osteogenesis for rapid orthodontic canine retraction. *J Oral Maxillofac Surg.* 2002; 60:389-94.
29. Sayın S, AO Bengi, AU Gürton, K Ortakoglu. Rapid canine distalization by using the distraction of the periodontal ligament: a preliminary clinical validation of the original technique. *Angle Orthod* 2004; 74:304-315.
30. Liou EJW, CS Huang. Rapid canine retraction by using the distraction of the periodontal ligament. In: Samchukov ML, Cope JB, Cherkashin AM, eds. *Craniofacial Distraction Osteogenesis.* St Louis, Mo: Mosby, 2001; 461-74.