Research Article

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Rapid Canine Retraction by Dentoalveolar Distraction Methods

Anant Jyoti[1]* Sakshi Sharma[2] P. Narayana Prasad[3] Tarun Sharma[4] Tarun Rana[5] Rohit Singh[6]

[1]Reader, Department of Orthodontics & Dentofacial Orthopaedics, Awadh Dental College & Hospital, Jamshedpur, Jharkhand, India.
[2]Clinician at Dental World Ranchi, Ranchi, Jharkhand, India.
[3]Professor and Head, Department of Orthodontics & Dentofacial Orthopaedics, Seema Dental College & Hospital, Rishikesh, Uttarakhand, India.
[4]Professor, Department of Orthodontics & Dentofacial Orthopaedics, Seema Dental College & Hospital, Rishikesh, Uttarakhand, India.
[5]Reader, Department of Orthodontics & Dentofacial Orthopaedics, Seema Dental College & Hospital, Rishikesh, Uttarakhand, India.
[6]Reader, Department of Pedodontics & Preventive Dentistry, Sarjug Dental College & Hospital, Darbhanga, India.

ABSTRACT

Background: This article presents a new concept of "Retraction of Canine". A tooth-borne, custom made, intraoral distraction device is used to distract the canine distally into the first premolar extraction space following the cortication around canine, grooving vertically inside the extraction socket. It is activated 3days after the extraction. The anchor units are the first molar. This article involves left upper canines which are distracted bodily 6.5 mm into the extraction space within 3 weeks as seen in cephalometric and periapical radiograph. New alveolar bone was generated and remodelled rapidly in the mesial part of the canine during and after the distraction. It became mature and indistinguishable from the native alveolar bone 3 months after distraction. During distraction, no sagittal movement of the molar was observed. The radiographic examination revealed that apical or lateral surface root resorption of the canine was minimal. No periodontal defect or endodontic lesion was observed throughout and after distraction. It is concluded that the Dentoalveolar segment of canine could be rapidly distracted without complications. The rapid orthodontic tooth movement through distracting the Dentoalveolar segment cannot be emulated by current conventional orthodontic concepts and methods.

Keywords: Canine retraction, Dentoalveolar distraction.

INTRODUCTION

Distraction osteogenesis is a method of inducing new bone formation by applying mechanical strains on the preexisting bone. The formation of new bone is achieved through stretching of the callus in the osteotomy or corticotomy gap with distraction devices. It is suggested that the formation of the new bone in the osteotomy or corticotomy site with a width of approxaimately 1 mm per day can be achieved by this method[1].

In 2002, Kisnisci et al[2] introduced another technique for rapid canine retraction. In this approach, known as dentoalveolar distraction (DAD), the segment that contains the canine is transported as a bone block. It differs from the technique advanced by Liou and Huang to the extent that the periodontal ligament is not stretched. They performed a bone separation from the bone block containing the canine using corticotomies to allow the tooth to move along with the bone that surrounds it through a distraction osteogenesis process. Regardless of the technique, Rapid Canine Retraction (RCR) has proven well suited for the following clinical situations: Severe crowding, Class II Division 1 malocclusions, bidentoalveolar protrusion, root shortening and malformation, as well as in patients presenting with periodontal problems. These indications are justified by the fact that, since tooth movement is accomplished very quickly, with the canine being completely distalized in about two to three weeks without anchorage loss, the remaining space can be used for the rapid resolution of crowding. Rapid

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***Correspondence Dr. Anant Jyoti.**
Department of Orthodontics & Dentofacial Orthopaedics, Awadh Dental College & Hospital, Jamshedpur, Jharkhand, India.
Email: Not Disclosed

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canine retraction features the following key advantages: A significant reduction in treatment time from 6 to 9 months, elimination of intra or extraoral anchorage during the procedure, which ensures nearly complete anchorage preservation, added to the fact that it does not damage the periodontium, nor does it affect pulp vitality. Disadvantages include the need for a specific surgical procedure and a supervised activation protocol, in addition to difficulties in fabricating distractors using Hyrax-type expanders, as devices suitable for this purpose are not yet available on the domestic market. The aim of this study was to discuss various parameters affected by Dentoalveolar Distraction.

AIMS & OBJECTIVE

To evaluate various parameters of Rapid Canine Retraction in 1st premolar extraction cases using

The parameters

- Rate of canine retraction
- Displacement of the canine and anchorage loss.
- Mean change in canine angulation
- Pulp vitality of the canines

MATERIAL AND METHODS

Class I or II patients who needed orthodontic treatment with fixed appliances and tooth extractions were selected for this study. All patients were in the permanent dentition and had moderate to severe crowding or increased overjet at the start of treatment. The study sample consisted of 8 maxillary canines in 8 growing or adult subjects (6 female, 2 male).

DIAGNOSIS AND ETIOLOGY OF A CLINICAL CASE

A female patient, aged 23 years 9 months, with Class I with Bimaxillary protrusion, came for orthodontic treatment with the chief complaint of "Forwardly placed teeth in upper front region." The facial photographs (Fig.1) showed proportional facial thirds and a convex profile. The intraoral photographs and dental casts show an overjet of 4 mm, an overbite of 25%, negative tooth-size discrepancies of 4 mm in both the maxillary and mandibular arch, and deviation of the lower midline to right by 1 mm to both facial and upper midline. The cephalogram and its tracing show the skeletal Class II pattern with an ANB angle of 6 degrees. The maxillary and mandibular incisors were proclined; The patient exhibited tendancy towards horizontalgrowth pattern. The panoramic radiograph shows that all teeth were present.

TREATMENT OBJECTIVES

The treatment objectives were to correct the inclination of incisors in both the arches, correct the midline deviation, achieve a normal occlusion with ideal overjet and overbite, reduce the protrusion of the upper and lower lip, and improve the facial profile.

TREATMENT PLAN

It was decided to extract all the first premolars to eliminate the crowding and correct the inclination of the incisors. Both conventional and rapid canine distalization (DAD) procedures were explained to the patient and her parents. The patient preferred rapid orthodontic treatment than the conventional technique. Then, surgery, distraction osteogenesis protocol, and orthodontic procedures were described in detail, and an informed consent was signed by the patient and her parent.

The treatment plan therefore consisted of all the first premolar extraction and rapid canine retraction followed by fixed appliance orthodontic treatment.

DISTRACTOR CONSTRUCTION

A custom-made intraoral distraction device was fabricated from a hyrax expander (11mm) which was trimmed, ground, and polished . After construction of the distractor screw, it was soldered to the bands of the first molars and the canines that had been previously transferred to a dental cast[7]. Before soldering to the bands(Fig.2), the distractor screw was opened an amount equal to the mesiodistal width of the premolar to be extracted.

DISTRACTION PROTOCOL

The distraction procedure was initiated after 3 days of latency period on the side of Dentoalveolar distraction[2]. The distraction device was activated twice a day at a rate of 0.8 mm/d[5]. After the completion of the distraction procedure, the

treatment was continued with conventional fixed appliances.

SURGICAL PROCEDURE

Surgery was performed on an outpatient basis, with the patient under local anesthesia. A horizontal mucosal incision was made parallel to the gingival margin of the canine and the premolar beyond the depth of the vestibule. Cortical holes were made in the alveolar bone with a small, round, carbide bur from the canine to the second premolar, curving apically to pass 3 to 5 mm from the apex(Fig.3). A thin, tapered, fissure bur was used to connect the holes around the root. Fine osteotomes were advanced in the coronal direction. The first premolar was extracted and the buccal bone removed between the outlined bone cut at the distal canine region anteriorly and the second premolar posteriorly. Larger osteotomes were used to fully mobilize the alveolar segment that included the canine by fracturing the surrounding spongious bone around its root off the lingual or palatal cortex. The buccal and apical bone through the extraction socket and the possible bony interferences at the buccal aspect that might be encountered during the distraction process were eliminated or smoothed between the canine and the second premolar, preserving palatal or lingual cortical shelves (Fig.4). The palatal shelf was preserved, but the apical bone near the sinus wall was removed, leaving the sinus membrane intact to avoid interferences during the active distraction process. Osteotomes along the anterior aspect of the canine were used to split the surrounding bone around its root from the palatal or lingual cortex and neighboring teeth. The transport dentoalveolar segment that includes the canine also includes the buccal cortex and the underlying spongy bone that envelopes the canine root, leaving an intact lingual or palatinal cortical plate and the bone around the apex of the canine. The incision was closed with absorbable sutures, and an antibiotic and a nonsteroidal anti-inflammatory drug were prescribed for 5 days. The surgical procedure lasted approximately 30 minutes.

TREATMENT PROGRESS

On the third day,the appliance was cemented and the distraction procedure was initiated. The patient or the parent turned the screw a quarter turn 2 times/twice a day. The patient was seen every third day during the distraction process. The canines were fully retracted in 13 days on the Dentoalveolar distraction side(16 days after surgery)(Fig.5). After completion of distraction, the distractor was removed. In the same session, brackets were bonded, and a ligature was placed that joined the canine and the second premolar.

In the surgical technique, the importance of depth and position of the undermining groove are highlighted, beyond the canine apex. Periapical radiographs of the canines and first molars and cephalogram were obtained before and after the distraction procedure.

Records and data collection

Determination of distal displacement and Rate of Retraction of canine

The distance between the contact points of the canine and lateral incisor at their most convex prominencies (amount of retraction) was recorded to 0.01 mm with a sliding caliper directly in patient mouth after distraction of canines (Fig.5) and rate of retraction was calculated from dividing distance by time.

Determination of Time Taken

The time (in days) required for bringing the canine to come in contact with the second premolar gives the total time

Determination of Change in Canine And Molar Angulation

The changes that occurred during the rapid canine retraction were assessed by examining the panoramic radiographs taken before and after the distraction. All panoramic radiographs were taken with the same orthopantomograph (Orthoralix 9200, Gendex). Each patient was instructed to keep their lips in resting position. The parallelism of Frankfurt horizontal plane was affirmed. To analyze the panoramic radiographs, four reference points were determined as described by *Ursi et al*[4] and two reference planes were formed by using these points (Fig.7). Additional planes were constructed by connecting the coronal and apical points of root

canals of the canines. Apical and coronal points of the palatal root canal in the upper first molars were used in constructing the reference planes. A total of four angular measurements were made with these points and planes.The axial inclinations of the canines and molars were measured on the panoramic radiographs taken before and after the distraction.

Determination of Mesial Movement of Molar (Anchor Loss)

To evaluate the amount of anchorage loss, alginate impressions were taken on all eight patients and casts were poured accordingly. The anchorage loss was assessed by determining the location of maxillary raphe by using two predetermined reference points as described *by Haas and Cisneros*[5]. On the maxillary dental model, two points- namely, one at the distal aspect of the incisive papilla and the second at the posterior border of the raphe near the fovea centralis were used to define the median raphe that was used as the dental midline (Fig.8). The maxillary (R1) reference plane was formed by plotting tangents to the interdental contact points of the upper central incisors (R1 was constructed to intersect Rp vertically). The perpendicular distances from the mesiobuccal cusp tip of the first molars to the reference line were measured (Fig.8). A transparent grid was used to measure the amount of canine and molar movements in the model analysis.

RESULTS

The distraction procedure was completed in 14.50 +/- 2.45 days on the side of Dentoalveolar distraction. No significant anchorage loss was seen. The distal displacement of the canines was 6.91 +/- 1.16 mm on the side of Dentoalveolar distraction at the rate of 0.48 +/- 0.08 mm/day. An angulation change of 14.88 +/- 3.15 degrees was seen in the Dentoalveolar Distraction side. Clinical and radiographic examination showed no evidence of complications, such as root fracture, root resorption, ankylosis, and soft tissue dehiscence, in any patient. No apical root resorption was detected in any subject at the start or at the end of distraction. Patient reported minimal to moderate discomfort, especially during the first 2 days after surgery, and mild edema was observed which got resolved in 2 days.

Table 1: Duration Of Distraction.

PATIENT 23

(DENTOALVEOLAR DISTRACTION)

1	13
2	13
3	12
4	16
5	18
6	13
7	13
8	18
MEAN	14.50
STANDARD DEVIATION	2.45

Table 2: Rate Of Distraction

PATIENT 23 (DENTOALVEOLAR DISTRACTION)

1	0.58
2	0.51
3	0.53
4	0.40
5	0.50
6	0.55
7	0.38
8	0.39
MEAN	0.48
STANDARD DEVIATION	0.08

Table 3. Angular Changes In Canines

PATIENT 23: (DENTOALVEOLAR DISTRACTION

1	15.5
2	11.5
3	16
4	19.5
5	15
6	13.5
7	10

8	18
MEAN	14.88
STANDARD DEVIATION	3.15

Table 4. Anchorage Loss In Molars

PATIENT 26

1	0.75
2	1.0
3	1.75
4	0.0
5	0.0
6	2.0
7	0.5
8	0.75
MEAN	0.84
STANDARD DEVIATION	0.73

Table 5: Results Obtained From Vitality Tests

PATIENT TOOTH READING AFTER DISTRACTION

1	23	No response
2	23	No response
3	23	3.2
4	23	No response
5	23	No Response
6	23	4.2
7	23	No response
8	23	3.0

DISCUSSION

Duration of Distraction

The rate of biologic tooth movement with optimum mechanical force is approximately 1 to 1.5 mm in four to five weeks[6], therefore in maximum anchorage premolar extraction cases, canine distalization takes 6 to 9 months, contributing to an overall treatment time of 1.5 to 2 years. With the custom-made, rigid, tooth-borne distraction device, the canines were retracted at an average rate of 0.48mm per/day on the DAD side in compliance with the principles of Distraction Osteogenesis. In Dento Alveolar Distraction(DAD) technique, horizontal and vertical osteotomies surrounding the canines are made to achieve rapid movement of the canines in the dentoalveolar segment, in compliance with the principles of distraction osteogenesis[2].

On the DAD side – The mean distraction time was 14.50 +/- 2.45 days and the distraction procedure was completed in 12 to 18 days.

The reason for variation in duration of distraction of canine might have been the resistance of the osteotomized bone fragments against the desired movement, or variable surgical procedures by the surgeons or even different parameters of the distractor.

Rate of Retraction

In DAD, vertical corticotomies were performed around the root of the canine, and the spongy bone around it was split. With this surgical technique, the dentoalveolus is used as a bone transport segment for rapid posterior movement of the canines. The surgical technique does not rely on stretching and widening of the periodontal ligament, which prevents overloading and stress accumulation in the periodontal tissues. Neither the buccal or the apical bone through the extraction site nor the palatal cortical plate interfered with the movement of the canine-dentoalveolus segment during the distraction procedure because of the surgical procedure.

The mean rate at the DAD side is 0.48 +/- 0.08 mm per day. Mean distance moved by canine in DAD, it is 6.91 +/-1.16 mm. The reason for the variation in rate of distalization might be due to the more invasive surgical procedure involved in

Dentoalveolar Distraction, resistance of the osteotomized bone fragments against the desired movement in for the procedures and patient's casual approach towards following the distraction protocol.

Angular Changes in Canine during Retraction

Although every attempt was made to achieve bodily movement of the canines with Distraction Osteogenesis (arms of the distracters were placed as incisal as possible and as long as possible to be more close to the centre of resistance of canines), a significant amount of tipping of the canines was observed suggesting that the distal displacement of the canines was mainly a combination of tipping and translation. A mean change in canine inclination of 14.88 +/- 3.15 degrees in the DAD method was seen at the end of the distraction period. The difference in change in canine angulation was statistically significant in both the methods.

This variation in angular change may be due to the anatomical structures present close to the apex of canine limiting the surgical intervention, variation in positioning of the arm of the distractor on canine or even variation in bone density among individuals.

Anchorage loss in Molars

After the initial tooth movement, a lag period of minimal tooth movement persists for approximately 2 to 3 weeks before tooth movement again proceeds[7]. A high orthodontic force strangulates the periodontal ligament and causes necrosis. The initial obstacle to orthodontic tooth movement is the necessary elimination of the necrotic tissues by undermining resorption. The elimination of the hyalinizing tissues takes 2-3 weeks, which is the lag period. In this study, the canine distraction was completed while the first molar was still in its lag period or just initiating its mesial movement[2].

In this study the canine was retracted within the lag phase of molars causing minimal anchor loss. Full retraction of the canines was achieved, and the anchorage teeth (first molars) were able to withstand the retraction forces with minimal anchorage loss. The mesial movement of the molars on the DAD side was within a range of 0.0 – 2.0 mm. with the mean being 0.84 +/- 0.73 mm.

Pulp Vitality of the Canines

Three of the Eight teeth were vital according to the results obtained from the electrical vitality test that was performed after distraction. No meaningful findings were achieved with the Electronic Pulp Tester, as the distracted canines preserved their pulp vitality at the end of distraction and the pulp-vitality test is not a reliable technique when performed during orthodontic tooth movement[8].

Findings of our study indicate that the distal movement of the canines is a combination of tipping and translation. This means that the crown moves more than the root apex, and similar to the neurovascular bundle in mandibular distraction, the pulp tissues of the teeth will remain vital under controlled rapid stretching[6]. Hence, the observed tipping of the canines might be an advantage with regard to pulp vitality during rapid tooth movement with both the procedures. Further investigation of pulp vitality is needed in patients subjected to rapid tooth movement with distraction.

CONCLUSIONS

Rapid Canine Retraction by the Dentoalveolar Distractionmethod is a promising technique with which the canines can be fully retracted in quick time.

The following patients could benefit from the technique:

- ✓ Those with moderate or severe crowding
- ✓ Those with Class II Div 1 malocclusions with overjet
- ✓ Those with bimaxillary dental protrusion.

This techniques reduce orthodontic treatment duration by 6 to 9 months in patients who need extraction, with no unfavorable short-term effects in the periodontal tissues and surrounding structures thereby reducing treatment time and improving patient compliance.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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