Changes in Canine Angulation after Dentoalvelaor Distraction with a Rigid Maxillary Intraoral Distractor: A Radiographic Study

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ABSTRACT

Introduction: Prolonged treatment duration is a major problem of orthodontic patients. Canine retraction through dentoalveolar distraction osteogenesis was introduced to reduce the overall orthodontic treatment period.

Objective: To evaluate the canine angulation by means of dentoalveolar distraction osteogenesis to achieve rapid canine retraction.

Materials & Method: The study sample consisted of 20 maxillary canines in 10 adult patients (mean age 19.53 years). First bicuspids were extracted, a rigid custom made intraoral distractor was placed, distraction osteogenesis surgical procedure was performed.

Result: Complete retraction of canines was achieved in a mean duration of 9.23 days with minimal anchorage loss. The mean change in canine angulation was 10.13° ± 3.44°. Bodily movements of the canines were noticed with minimal tipping of mean 7.11° (6°-8° range). No radiographic and clinical complications were encountered.

Conclusion: There was a significant change in canine angulation after distraction.

Key words: canine distraction, canine rotation and angulation, dentoalveolar distraction rigid distraction device

INTRODUCTION

Distraction osteogenesis (DO) is a process of growing new bone by mechanical stretching of the preexisting bone tissue.[1] It has gained its widespread recognition in orthopedic surgery as an effective means of bone lengthening, deformity correction and filling large diaphyseal defects. Recently distraction osteogenesis has been extensively applied to the craniofacial complex and is increasingly becoming a viable treatment option in the correction of craniofacial deformities.

Most orthodontic patients present with tooth crowding. Although non-extraction treatment has become very popular during the last decade many patients do need extractions.[2] The first phase of treatment in premolar extraction case is the distal movement of the canine with conventional techniques. Extraoral or Intraoral anchorage is required during canine distalization particularly when maximum anchorage is required. Biologic tooth movement with canine retraction phase usually lasts for 6 to 8 months. The duration of treatment is one of the problems that orthodontic patients complain mostly by adults. To address this problem dentoalveolar distraction osteogenesis (DAD) technique has been developed.

In the present technique of rapid orthodontic canine retraction through distraction osteogenesis as described by Reha-kisnisci and Halukiseri;[2] the dentoalveolus is itself is designed as a bone transport segment for posterior movement. Vertical osteotomies are performed around the root of the canine followed by splitting of spongy bone around it. Therefore the design of surgical technique itself does not rely on the periodontal stretching which obviates overloading and stress accumulation in this tissue, which was the drawback of the previous attempts of canine distraction through periodontal ligament as described by Eric Liou, Shing Huang.[3] This procedure does not require any extraoral force and has significant clinical application.[4,5] A tooth can be moved into the fibrous new bone created by the distraction process at a rapid rate.[6] Thus using distraction osteogenesis technique rapid tooth movement can be achieved. The purpose of the study was to evaluate the changes in canine angulation after dentoalvelaor distraction with a rigid intraoral distractor in the maxilla.

MATERIALS AND METHOD

Twenty maxillary canine distractions were performed on orthodontic patients using custom made intraoral distractor on the basis of inclusion criteria. Patients were selected those who required extraction of maxillary first premolars with maximal anchorage. Maximal canine teeth were reasonably placed within the arch without rotation and without considerable tipping. Patients had periodontally healthy teeth.

Subjects were excluded when the canines were placed in excessive palatoversion or labioversion, canines with severe rotation or tipping, abnormal curvature of the canine roots, non-vital tooth. Subjects with poor oral hygiene and periodontally weak teeth, presence of any systemic illness, and poor internal motivation were also excluded.

A total of ten adult patients with 5 females and 5 males in the age range of 14-23 years (mean age 19.53 years) scheduled for orthodontic treatment with first bicuspid extractions were selected for the study; they subsequently underwent canine distalization with distraction osteogenesis procedure.

The canine distractor used in the study was a custom -made, rigid, intraoral, tooth borne device made of stainless steel. Bands were fabricated and placed on maxillary canines and first molars, then impression was taken with alginate. The bands were then transferred to the impression and poured with die stone. The distractor of appropriate length was soldered to the bands directly.

The distractor device consisted of (Figure 1):

1. The anterior segment consisted of canine band and two non-grooved slots for the sliding rod and screw.
2. The posterior segment consisted a molar band and a slot to which the sliding rod is soldered and a grooved screw slot.
3. The length of the screw was arranged according to the distance between the distal point of the canine and the mesial point of the first molar.

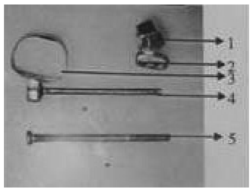

Figure 1: Distractor device

4. Sliding rod is soldered to the posterior segment. The anterior segment slides through it during the activation of the screw.
5. Screw wrench to advance the screw. Since the distractor was unilateral, a 3600 activation of the screw in a clockwise direction with the screw wrench produced 1.0 mm of distal movement of canine tooth.

Surgical procedure

All patients underwent surgery on an out-patient basis under local anaesthesia. A horizontal mucosal incision of 2 to 2.5 cm long was made parallel to the gingival margin of the canine and bicuspid teeth well beyond the depth of the vestibule. Subperiosteal elevation was carried out to expose the canine root and first premolar region. A vertical osteotomy was made on the anterior aspect of the first premolar using multiple cortical holes with a round bur under copious irrigation. The osteotomy was curved apically and continued posteriorly in a similar manner in the anterior aspect. A thin tapered fissure bur was then used to connect the holes around the first premolar root. The first premolar was extracted at this stage along with the buccal cortex using appropriate forceps. A vertical osteotomy was then made on the anterior aspect of the canine tooth to be distracted posteriorly using multiple cortical holes made on the alveolar bone with a small round bur under copious irrigation. The depth and location of the cortical holes were dictated by the proximity of the neighbouring tooth (Figure 2).

The osteotomy was continued and curved apically passing 3 to 5 mm from the apex. A vertical osteotomy

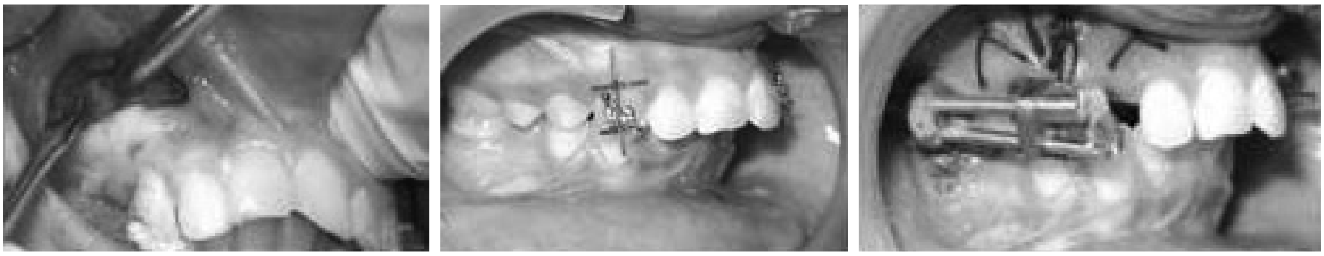

Figure 2: Surgical Procedure of distractor placement

was made in a similar manner along the posterior aspect of the canine tooth. A thin tapered fissure bur was used to connect the holes around the canine root. The root of the canine was then outlined anteriorly and posteriorly with a cone shape at the apical region. Fine osteotomies were then introduced and advanced in the coronal direction. The bone apical to the extraction socket and the possible bony interferences at the buccal aspect that may be encountered during the distraction process were eliminated and smoothened between canine and second premolar with the preservation of the palatal cortex. Osteotomies were then used along the anterior aspect of the dentoalveolar segment that includes the canine tooth to split the surrounding bone around its root off from the palatal cortex and neighbouring teeth. The osteotomy cut was performed between the palatal cortex and the palatal aspect of the canine root, taking care of the canine root, without involving the lamina propria using a thin curved spatula osteotome keeping it close to the palatal cortex. The transport dentoalveolar segment includes the buccal cortex and the underlying spongy bone that envelopes the canine root, leaving an intact apical, palatal cortical plate (Figure 2).

The wound was irrigated with saline and closed in a single mucosal layer with 3-0 catgut suture. The distraction device was fitted and cemented to the first molar and canine teeth at the end of the surgical procedure. The patient was prescribed antibiotics and anti-inflammatory drugs for 5 days. Dentoalveolar distraction was started on the day of surgery and continued at a rate of 0.5 mm twice a day. There was no latency period. It was discontinued when the canine tooth moved posteriorly into the desired position.

The distracted dentoalveolar segment after distraction was kept for 3 months of consolidation period till the radiographic evidence of bony regenerate was confirmed. Later orthodontic therapy was carried out with fixed appliance. During and after the completion of activation phase, as well as during early and late consolidation periods, the following records were obtained for each patient;

1. Standard photographs (extraoral and intraoral)
2. Periapical radiographs of the maxillary canines with acrylic jigs (Figure 3)
3. Study models were made during pre- and post-distraction periods (Figure 4).

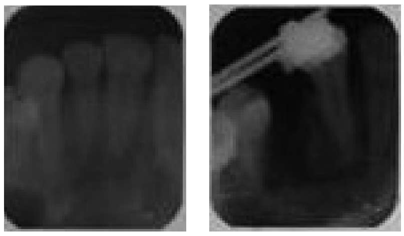

Figure 3: Periapical radiographs; before & during procedure

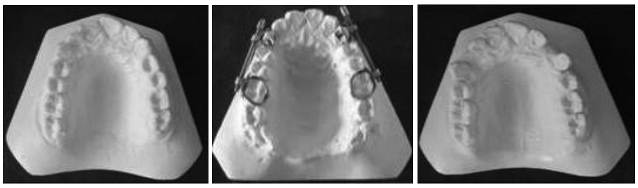

Figure 4: Study models; before, during & after procedure

Determination of canine tipping

To analyze inclination of canine, lateral cephalometric radiographs were taken before and after canine distraction (Figure 5). Orientation markers were fabricated using custom made acrylic zigs with brackets on canines to be distracted with Stainless steel wire soldered vertically to the canine band. The canine brackets with vertically oriented markers were temporarily ligated in patient's mouth, which invariably coincided with crown and root angulation of canine.

Cephalometric radiographs were taken with the orientation markers in place before the placement of distraction device pre-operatively. These markers were removed after initial cephalogram and were stored with the name of the patient and the side of the canine specified. At the end of the canine distraction (consolidation phase), after the removal of the distraction appliance, postoperative cephalogram was taken again with the same markers which was temporarily ligated to the canine brackets.

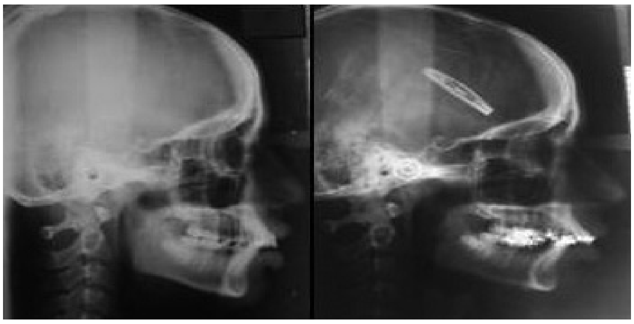

Figure 5: Cephalometric radiographs; before & after procedure

The composite tracing was done on the pre-distraction and post-distraction lateral cephalograms. The amount of canine tipping was measured with reference to palatal plane (ANS-PNS) using ANS as the reference point. The amount of canine tipping was calculated by difference of tip between the markers in pre-distraction and post-distraction cephalometric radiographs. Thus the angulation of the canine to the palatal plane was measured. Each measurement was made twice and the values were recorded. (Table 1)

Table 1: Degree of tipping of canine

Patient No.	Tooth (FDI Notation)	Degree of Canine Tipping
1	13	9°
	23	10°
2	13	2°
	23	3°
3	13	2°
	23	2°
4	13	2°
	23	2°
5	13	2°
	23	3°

RESULTS

The results were evaluated based upon clinical and radiographic findings (Figures 6,7). Clinically and radiologically, although some canines tipped slightly after distraction most of the canines moved bodily with minimal amount of tipping of about 3.4° on an average. In our study, maximum amount of tipping occurred was 10° and minimal amount of tipping occurred was 2°. Canine roots were parallel to the long axis of second premolar after the distraction.

Immediate post operative complications were slight discomfort, pain and swelling over the surgical site, tenderness over premolar-molar regions, injury in the cheek due to impingement of distal end of the distractor screw. These problems were subsequently resolved within one week post-operatively. Impingement of distractor screw was managed by cutting the appropriate length of the screw end.

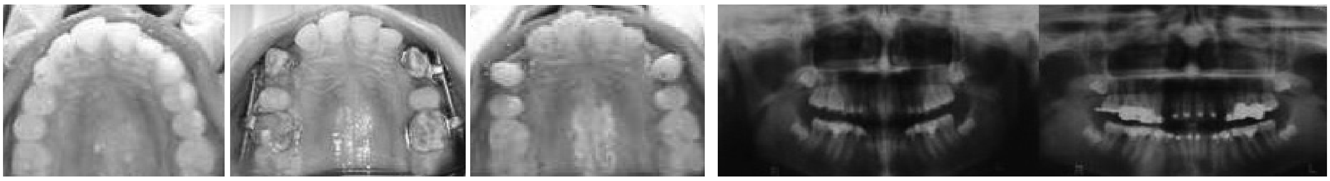

Figure 6,7: Clinical and radiographic progress records

DISCUSSION

Orthodontic tooth movement is a process whereby the application of force induces bone resorption on the pressure side and bone apposition on the tension side. Thus consolidation period is one of the most important phases of distraction osteogenesis.[7]

Classically, the rate of orthodontic tooth movement depends on the magnitude and duration of the force, the number and shape of the roots, the quality of bony trabecula, and patient's compliance. The rate of biologic tooth movement with optimum mechanical force is approximately 1 to 1.5 mm in 4 to 5 weeks. Therefore in maximum anchorage premolar extraction cases, conventional canine distalization usually takes 6 to 9 months, contributing to an overall treatment time of 1.5 to 2 years.

Although every attempt was made to achieve bodily movement of the canines with distraction osteogenesis, a significant amount of tipping of the canines was observed. Therefore, the distal displacement of the canines was mainly a combination of tipping and translation.

Bodily movement of canine was noticed in all the cases with minimal amount of tipping of mean 7.11° (6° to 8° degrees range). The tipping of maxillary canine was analyzed on cephalometric superimposition of pre-distraction and post-distraction cephalograms with custom made markers in place (Ahmet Keles *et al*).[8] The degree of tipping of canine was calculated in relation to the palatal plane. The probable reason for less tipping could be the osteotomy cut around the canine root, relieving bony interferences in the apical region of socket that can be encountered during tooth movement. The other reason is keeping the orientation of the distraction appliance close to the center of resistance of canine tooth. Burstone *et al* stated that the center of resistance of a single-rooted tooth of parabolic shape is situated at a distance from the alveolar crest to the apex of the root. A force passing through the center of resistance would produce bodily movement. Compared to other studies we encountered less amount of tipping of mean 7.11°. Zeigler and Ingervall *et al* reported tipping of 8.5°, Liou and Huang *et al* reported 17°, Seher Sayn and Osman Bengi *et al*[9] reported 11.5 degrees of canine tipping during rapid canine retraction.

Orientation of the distraction device was parallel to the maxillary occlusal plane and distraction vector orientation was horizontal. It is said that tipped canine can then be uprighted during retraction of the anterior teeth and finishing procedure later. Also considerations should be given that the canine on the recent extraction site move faster than that on the healed side, but with more amount of tipping, as the centre of resistance of tooth may be located further apically and bone distal to canine being denser near the apex than the marginal area.

OJN

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