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Successful Endodontic Management of Aberrant Mandibular Premolar Morphology

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Abstract

Aim

To evaluate the treatment effect of surgically assisted canine retraction by two Custom made canine distraction device and modified Hyrax canine distraction device.

Methods and Material

The aim of study was to design a custom made canine distraction device having Good control on canine. The subject were divided in two Group, Right maxillary canine distracted with custom made canine distraction device and other Left maxillary canine distracted with Modified Hyrax Canine distraction device (Control side). The rate and duration of canine retraction, tipping of canine and vitality was compared with both the distraction device. The Ten orthodontic Patients having severe and moderate crowding or increase overjet of Class II and Class I malocclusion in the age range of 13 to 26 years were chosen. The osteotomy cut was given around maxillary canine and Distracted distally with Distraction device. The OPG analysis was performed to analyze tipping of canine. Duration and Rate of Canine Distraction with Digital calliper. Model analysis for amount of canine movement and anchorage loss.

Results

The canine retraction was completed with custom made canine distraction device (Group-I) in 10.20 days in compared to modified hyrax distraction(Group –II) device in 13.80 days. The rate of canine retraction with

Custom canine distraction device (Group-I) was 0.74± 0 .06mm per day compared to modified hyrax canine distraction device (GROUP-II) which was 0.55+ 0.06 mm per day. The canine tipping is less with Group I distraction device compared to Group II distraction device. There was no significant Anchorage loss between Group-I and Group-II (P=0.08)

Conclusions

The Distraction Osteogenesis for rapid canine retraction is an innovative and feasible method for canine retraction which reduces treatment time significantly. The customized canine distraction device has better tipping control and faster rate of canine retraction.

Keywords

Surgically assisted canine retraction, customized canine distraction device, Hyrax device.

Introduction

One of the great challenges in high anchorage cases is to reduce treatment time without compromising function and aesthetics. The goal of recent Orthodontic research was to minimize the discomfort with least damage of supporting tooth structure, to reduce the duration of orthodontic treatment with minimum clinical appointment and controlling the anchorage loss. The long duration of orthodontic treatment period is major complain for both patient including adult patient and orthodontists. The first phase of fixed mechano-therapy is first premolar extraction and distal movement of canines. Correct positioning of canine after retraction is important for function, stability, and aesthetics. Canine retraction has advantage of less anchorage loss and proper torque control of incisors.

Canine retraction is slow process1. Conventional orthodontic mechanics achieve canine retraction at the rate of 1mm per month and last for usually 6 to 8 month2. Most of severe crowding cases require anchorage preparation. Any attempt to increase rate of orthodontic tooth movement leads to loss of anchorage control. Preservation of anchorage is very important in severe crowding cases3. Extraoral or intraoral anchorage mechanics are required to maintain the space obtained during canine retraction. None of the conventional orthodontic technique is satisfactory in term of good anchorage control.

Distraction osteogenesis is a biologic process of new bone formation between the surfaces of osteotomized bone segments that are separated gradually by incremental traction4. A bone fracture is surgically created and the two ends of the bone are apart, slow enough so that new bone can grow in the gap. Distraction osteogenesis is successfully used in craniofacial deformity from long period5. The concept of distraction osteogensis for canine retraction is first introduced by liou and Hang in 19986. He demonstrated rapid canine retraction by periodontal ligament distraction in human within three weeks. In 2001, Iseri and kisnisci introduced dentoalveolar distraction, using the principle of dentoalveolar distraction osteogenesis for rapid tooth movment7.

The aim of this clinical study was to develop a canine distraction device and evaluation of the effects of canine retraction on dentoalveolar tissue using the principle of dentoalveolar distraction technique. In this study we presented a comparison of rigid, bidirectional, tooth born Custom distraction device with a modified hyrax distraction device.

Subjects and Methods

The sample consisted of 20 maxillary canine teeth in 10 patients (6males and 4females) Treatment planed for fixed orthodontic treatments were included in study. Class I and II patients who were in permanent dentition with moderate to severe crowding and/or an increased

overjet. The mean age of the patients was with range of 13-26 years at the start of treatment. The patient and their parents were informed about the purpose of surgical procedure, and also alternative conventional treatment option. Each patient is divided in two Groups:

GROUP I: Custom made canine distraction device placed on right maxillary canine and first molar.

GROUP II: Modified hyrax canine distraction device placed on left maxillary canine and first molar.

Appliance design:

GROUP I: Custom made canine distraction device: Custom made rigid, tooth borne, intraoral distraction devices were designed by our team and used in retraction of right maxillary canine of the patient. The device was made of stainless steel, with one distraction screw and one guidance bar. The distractor was activated with surgical mini-plate screw driver in a clock wise direction. Maxillary canine and maxillary molar are banded with rocky mountain orthodontics (RMO) band material. Canine was banded with 0.150x0.003 (inch) and molar with0.180x0.005 (inch) band. Alginate impression taken and poured with plaster of Paris. Molar retention arm and canine retention arm were adapted to the banded molar and canine respectively. The pitch of distraction screw is 3600 =0.4 mm. The weight of custom-made distraction is 2.88gm. The parent of patient were demonstrated and taught to turn the screw with surgical mini-plate screw driver in a clockwise direction. The screw was activated in morning and evening.

GROUP II: Modified hyrax canine distraction device:Hyrax rapid expansion screw which can open up to 13mm is selected for fabrication of modified hyrax distraction device. One arm of Hyrax is cut with carbide bur. Modified hyrax having screw and guidance bar is adapted to molar and canine band and soldered. The pitch of hyrax is 3600=0.8mm.

Surgical Procedure

All Surgery was performed in minor O.T under local anesthesia on an outpatient basis under aseptic conditions. A crevicular incision was made from mesial of canine to mesial of molar and vertical releasing incision was given from mesial of canine to vestibular sulcus depth. An L-shaped subperiosteal elevation was carried out to expose the canine root and bicuspid teeth. Cortical hole were made in the alveolar bone with a 701 ss white carbide bur from canine to second premolar under copious irrigation, curving apically to pass 3 to 5mm from the apex. O.P.G and I.O.P.A were used to evaluate the maxillary sinus position. A thin, tapered, fissure bur was used to connect the hole around the root. Fine osteotomes were advanced in the coronal direction. The root of the canine tooth thus was outlined anteriorly and posteriorly with rectangular shape at apical region. 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 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 smoothened between the canine and the second premolar, preserving palatal or lingual cortical shelves. The cortical bone at the apical region was also relieved for maximal bodily movement during distraction. The palatal shelf was preserved. In cases in which the apex was closely situated at or above the antrum floor , the bone between and in front of the

moving axis of the root was removed or thinned out using round burs, with the maxillary sinus lining exposed to facilitate posterior movement of the dentoalveolar segment. 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 neighbouring teeth. The incision was closed with non-absorbable sutures, and an antibiotic and a nonsteroidal anti-inflammatory drug were prescribed for 5 days.

Fig 1: Osteotomy Cut around Canine

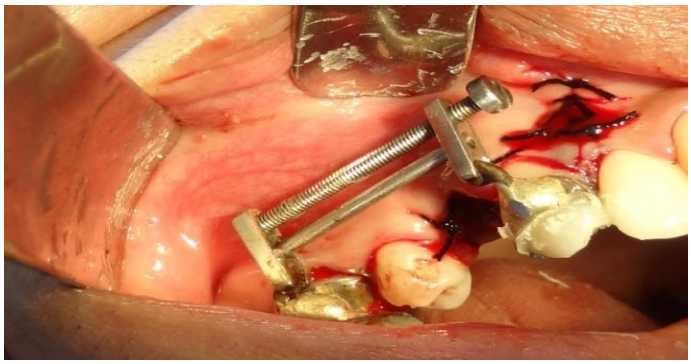

Fig 2: Custom Made Canine Distraction Device(Group-I)

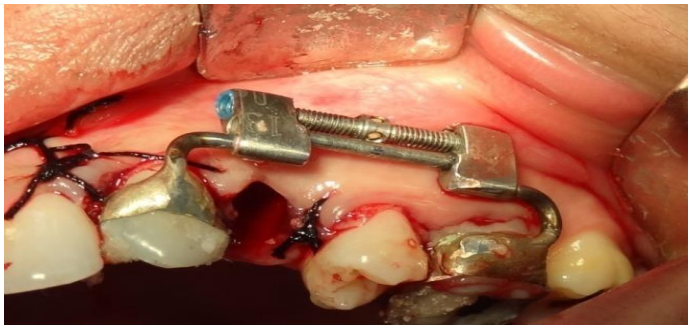

Fig 3: Modified Hyrex canine Distraction Device (Group-II)

Distraction

Protocol The distractor was cemented on the canine and the first molar immediately after the surgery under dry field with glass ionomer cement. Distraction was initiated on a third postoperative day. The distractor was activated twice per day, in the morning and in the evening, for a total of 0.8 mm per day. Immediately after the canine retraction was completed, fixed orthodontic appliance treatment was initiated, and the leveling stage was started in both dental arches. Ligatures were placed under the arch wire from the distracted canine and to the first molar for 3 months after the dentoalveolar distraction procedure4.

Clinical Measurements

Duration and rate canine retraction: The mesio-distal width first premolar was measured with digital calliper (Robust, Germany) in a patient mouth and also on Study model by same operator. Both the distractor was activated at the rate of 0.8mm per day. The distractor was activated till the distal surface of canine touches mesial surface of second premolar. The number of day was counted to close the first premolar space, which give duration of canine retraction. Rate of canine retraction Mesio-distal width of first premolar/ Duration of Canine retraction.

Panoramic Radiographic Analysis

The angular changes that occurred during the rapid canine distalization were assessed by examining the panoramic radiographs taken before and after the distraction. All panoramic radiographs were taken with the same orthopantomograph (Proline, PM 2002 CC) with each patient's lips in the resting position, the Frankfurt horizontal plane parallel to the floor, and the jaws in centric relation.Following Reference points and lines used in the panoramic radiographic analysis: UROr- the most inferior and lateral point of upper right

orbitULOr- the most inferior and lateral point of upper left orbit UROr-ULOr- line connecting point UROr to ULOr

To analyze the panoramic radiographs, two reference points were determined as described by Ursi et al and one reference planes were formed by using these points9. Additional planes were constructed by connecting the coronal and apical points of root canals of the canines. A total of two angular measurements were made with these points and planes. The axial inclinations of the canines were measured on the panoramic radiographs taken before and after the distraction, and the data obtained were analyzed10.

Model Analysis

To evaluate the amount of canine movement and posterior anchorage loss, alginate impressions were taken on all ten patients and poured in hard stone. The posterior anchorage loss and the amount of canine movement in the antero-posterior direction were assessed by determining the location of maxillary raphe by using two predetermined reference points11. The maxillary (R1) and mandibular (R2) reference planes were formed by plotting tangents to the interdental contact points of the upper and lower central incisors (R1 and R2 were constructed to intersect Rp vertically). The perpendicular distances from the cusp tips of the upper canines and the mesio-buccal cusp tip of the first molars to the reference line were measured. A transparent grid was used to measure the amount of canine and molar movements in the model analysis.

Vitality of Canine

An electrical vitality test was performed before and three month after the distraction procedure and electronic pulp tester (API). The probe of the pulp tester was placed on the incisal one-third of the buccal enamel surface of the tooth, and the current was increased gradually. Each patient was observed for signs of pain, and then the corresponding number on the scale was registered.

Statistical Analysis

The findings of measurements were statistically analysed. Mean and standard deviation were calculated for each parameter. The data obtained from study was evaluated and compared between the Custom made canine distraction device (GROUP-I) and modified hyrax canine distraction device (GROUP-II) using a parametric, unpaired student t-test.

Results

All the ten patients were surgically operated uneventful. Two patients reported with facial oedema. Eight patients reported with ulceration of buccal mucosa. Ulceration was observed in both the GROUP I-Custom made canine distraction device and GROUP II- Modified hyrax canine distraction device. No pain was observed during activation of distraction procedure. None of the patients reported with infection and any other serious complication.

Fig 4: Post DAD with Custom Made Distraction Device

Fig 5 Post DAD with Hyrex Device

The canine retraction was completed with custom made canine distraction device (GROUP-I) in 9 to 12days (mean10.20 +1.03) compared to modified hyrax distraction device (GROP-II) in 12 to 16 days (mean13.80 +1.48). The duration of surgically assisted rapid canine retraction was statistically significant (P=0.000) between Group-I and Group- II.

Table 1: Duration of canine retraction

	Group	N	Mean	Std. Deviation	Std. Error Mean
Duration of canine retraction in days	Group I	10	10.20	1.033	.327
	Group II	10	13.80	1.476	.467

The rate of canine retraction with custom made canine distraction device was 0.74+ 0 .06mm per day compared to modified hyrax canine distraction device which was 0.55+0.06mm per day. The rate of canine retraction was both clinically and statistically significant (P<0.05).

Table 2 : Rate of canine retraction

	Group	N	Mean	Std. Deviation	Std. Error Mean
Mesio-distal width of right first premolar in mm	Group I	10	7.70	.675	.213
	Group II	10	7.70	.675	.213
Rate of canine retraction in mm/day	Group I	10	.7400	.05637	.01783
	Group II	10	.5470	.05716	.01808

The minimum of 6o and maximum of 22o (mean12.20o +4.94o) canine tipping was observed custom made canine distraction device compared to modified hyrax canine distraction device where minimum of 10o and maximum of 28o canine tipping (mean19.20o +6.48o) was observed . The level of significance of angular change of canine due to Dentoalveolar distraction between two Group I and Group II was 0.00(P<0.05).

Table 3 : Angular change of canine

	Group	N	Mean	Std. Deviation	Std. Error Mean
Pre-DAD in degree	Group I	10	86.90	3.315	1.048
	Group II	10	89.70	4.057	1.283
Post-DAD in degree	Group I	10	99.10	4.149	1.312
	Group	10	107.90	6.297	1.991

	II				
Angular change in degree	Group I	10	12.20	4.940	1.562
	Group II	10	19.20	6.477	2.048

Tipping, extrusion and rotation of canine was observed in both the Groups.The minimum of 0mm and maximum of 2mm mesial migration of molar was observed with both the distraction devices was observed. The mean anchorage loss was 0.50+0.71 mm with custom made canine distraction device compared to 1.10+0.74 mm with modified Hyrax canine distraction device. Level of Significance of anchorage loss between Group-I and Group-II was non-significant (P=0.08).None of the canine showed root resorption, ankylosis or root fracture in Pre and Post Dentoalveolar distraction radiographic evaluation.

Table 4: Anchorage loss of molar

	Group	N	Mean	Std. Deviation	Std. Error Mean
Distal movement of canine in mm	Group I	10	7.10	.876	.277
	Group II	10	6.50	.707	.224
Mesial movement of molar in mm	Group I	10	.50	.707	.224
	Group II	10	1.10	.738	.233
Anchorage loss in mm	Group I	10	.50	.707	.224
	Group II	10	1.10	.738	.233

Discussion

The goal of this research was to minimize the discomfort with least damage of supporting tooth structure, to reduce the duration of orthodontic treatment with minimum clinical appointment and controlling the anchorage loss12. 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, canine retraction usually takes 6 to 9 months, contributing to an overall treatment time of 1.5 to 2 years13. Many attempts have been made during past decades to shorten orthodontic treatment time. Liou and Huang reported a rapid canine retraction technique involving distraction of the PDL after extraction of the first premolars through weakening of the interseptal bone6. The surgical method was described as an innovative approach; however, refinements in the surgical technique, such as the use of corticotomies versus full osteotomies and the applicability of the technique to teeth close to the mandibular dental nerve, were suggested. Corticotomy-assisted orthodontics has been suggested for reducing orthodontic treatment time. Gantes et al showed that mean orthodontic treatment duration was 14.8 months in the corticotomy-assisted group and 28.3 months in the control (without corticotomy) group. Chung et al stated that the combined use of orthopaedic traction and

corticotomy procedures can be effective for anterior retraction and posterior intrusion, and these procedures can shorten the orthodontic treatment time. The surgical procedure of corticomy-assisted orthodontics includes palatal and vestibular mucosal incisions and corticotomies. Iseri and Kisnisci et al described and clinically used a new technique for rapid retraction of the canines, the Dentoalveolar distraction. With this 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. Liou and Huang ,Iseri and Kisnisci et al used custom made canine distractor. Yusuf, Karaman; et al used Hyrax screw for canine distraction.

In this study we compared surgically assisted rapid canine retraction with custom made canine distraction device (Group I) with modified hyrax canine distraction device (Group II).The surgical procedure done under local anaesthesia. The aim was to design a canine distractor for surgically assisted rapid canine retraction which retracts a canine similar to conventional orthodontic canine retraction. The custom made canine distraction device was made of stainless steel used for making of surgical distraction devices. The weight of custom made canine distraction device was 2.88gm which was comparable to modified hyrax canine distraction device .The weight of modified hyrax distraction device was 2.86gm. The custom-made canine distraction device consisted of Molar retention arm (Posterior section), canine retention arm (anterior section), distraction screw and guidance bar. The posterior section included upper grooved screw socket for passing a distraction screw, lower non-grooved slot fixed to guidance bar and retention arm which was adapted and soldered on buccal side of first molar band. The anterior section included upper grooved screw socket for passing distraction screw, lower non-grooved slot for passing guidance bar and retention arm which was adapted and soldered on buccal side of canine band . The distraction screw was 30mm length. The top of the screw was designed thicker than grooved part and was of circular shape to facilitate patient activation of the screw with surgical mini-screw driver. The distractor was bilateral and activation was done in clockwise direction. A 360o activation of the screw produce 0.4mm of distal movement in the canine tooth (pitch, 360o=0.4mm). The length of the distraction screw was customized according to distance between canine and first molar. The distraction screw was placed 10mm above the gingival crevicular margin. The placement of distraction screw near to center of resistance produces bodily movement of canine. The length of guidance bar was 25mm and further customized after patient trial to prevent the ulceration of buccal mucosa. The purpose of guidance bar was to produce a translation of canine and to minimize the tipping movement of canine. The guidance bar act like a rigid arch wire, as used in conventional orthodontics to retract a canine in a straight wire appliance.

In the present study, custom made, intraoral, tooth-borne, rigid canine distractor was placed to retract a right maxillary canine (Group I) and modified hyrax screw distraction device was placed on left maxillary canine (Group II). The hyrax distraction device was open before adaptation and activated by closing with key. The distractor was placed after surgical procedure and the distraction device was activated on a third day after surgery. An advancement of 0.4 mm was performed two times a day until canine tooth was distracted into the desired position. Ulceration of buccal mucosa was found with in both the Group I and Group

II. The compliance was better with custom made canine distraction device (Group I). Parent of the patients reported that activation was easy and simple with custom made canine distractor (Group I) than modified hyrax canine distraction device (Group II). Vertical osteotomy cuts were made both mesial and distal of canine in the interdental region. Horizontal osteotomy cut placed 3 to 5mm above the apex of canine and extended in first premolar region to retract the canine without any interference. The surgical procedures were performed within 45 minutes. The surgical intervention was done in single sitting on both the right and left maxillary canine. The surgical procedure was same for both the Group I and II. All patients tolerated the surgery and the device after the surgery. Fixed Roth 0.022 appliance was started immediately after the termination of canine distraction in all patients. Dentoalveolar distraction reduces orthodontic treatment time by about more than 50% due to Regenerate bone formation and remodelling of bone14. There was no unfavourable long term effects on periodontal tissues and surrounding structures. The distraction duration was less with custom-made canine distraction device compared to modified-hyrax canine distraction device. Iseri and kisnisci reported that full retraction of canines was achieved in a mean 10.05days7. The canines were moved rapidly with canine distraction device into the extraction sites in 8 to 14 days, at the rate of 0.8 mm per day.

Conclusion

The Dent alveolar Distraction of Canine is an Innovative method and feasible for clinical practice. Use of surgical approach reduce treatment time and retract canines into the extration space of premolars within two week. Proper Designing and Customization of canine distraction device will give better control of canine position. Custom canine distraction device give better post distraction canine position.

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