Evaluation of Angular Changes of Canine in En Masse Retraction of Maxillary Anterior Teeth Using Power Arm and Titanium Mini-Implant - A Split Mouth Randomised Control Study

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ABSTRACT

BACKGROUND

This study was conducted to determine angular changes of maxillary canine in en masse retraction of anterior teeth in a new modified power arm with a conventional intraoral anchorage unit compared to a mini-implant anchorage in the first premolar extraction case. We wanted to compare angular changes of maxillary canine between modified conventional anchorage with a power arm and titanium mini-implant anchorage in en masse retraction.

METHODS

A total of 15 participants requiring maxillary first premolar extraction was selected for this study. In each participant, the en mass retraction was carried out with mini-implants on one side & modified conventional anchorage with a power arm on the other side. The choice of mode of retraction on the right and the left side was done based on the coin flip method. Angular position of the maxillary canine was evaluated on orthopantomogram (OPG) & diagnostic cast.

RESULTS

A mean disto-palatal rotation observed post retraction was of 9° on the conventional anchorage side & 9.86° on the mini-implant anchorage side. A mean difference in maxillary canine angulations post retraction was 1.13° on the conventional anchorage side and 0.93° on the mini-implant side. An increase in angle suggested the tipping of canine teeth. The difference was very small which was not statistically & clinically significant.

CONCLUSIONS

There was no difference in the type of tooth movement during retraction by mini-implant and power arm suggesting minimal variation in teeth movement in the anterior region. So, the choice mainly depends on the type of the anchorage required in the given clinical situation.

KEY WORDS

Anchorage, Mini-Implant, Power Arm, Type of Tooth Movement

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BACKGROUND

Anchorage preparation in orthodontics is one of the crucial factors that determine the outcome of the treatment.¹ The extraction of 1st pre-molar is necessary in many cases where there is severe crowding due to a discrepancy in tooth size and jaw size. 1st pre-molar extraction space is closed completely by retraction of anterior teeth in cases with anterior dental proclination.²

Routinely used retraction techniques are; two-step retraction method (retraction of canine tooth followed by retraction of all four incisors) and en masse retraction method (retraction of all six anterior teeth).³ The two steps retraction approach retracts canine independently, pursued by retraction of incisors, aiding a greater retraction of the anterior teeth by; dropping the tendency of anchorage loss.⁴ This two-step retraction method increases the treatment duration by rotating and tipping canine more than that of when the six anterior teeth are retracted as a single unit as desirable.^{5,6} But conventional intraoral anchorage techniques have not always been successful for en masse retraction. Silvia Geron et al. had shown in their study that the inclusion of the 2nd molars in the anchorage preparation, frictionless mechanics, and low retraction forces are recommended for the conventional anchorage.⁷ The angular and axial position of maxillary canine after orthodontic treatment depends on the direction of the force. Force passes through the centre of resistance of tooth this will lead to the bodily type of tooth movement which is most desirable. On the other hand, the tooth resists the maximum amount of force whenever the force passes through the center of resistance. This is one of the methods of conserving the anchorage loss.

After the introduction of mini screws, its use as a sole source of orthodontic anchorage was widely used in orthodontic treatment. Orthodontic mini screws have been inserted in different locations such as the alveolar bone, the retromolar region, the midpalatal region, and the lingual and buccal cortical plates. For accepting elastomers and ligatures, implants have a button like head.⁸

The disadvantages of implants are the risk factors associated with the failure rate, clinical characteristics, including sex, age, craniofacial skeletal pattern, and site and side of implantation, which have to be examined.^{9,10} Many patients face difficulties like loosening of mini-implants, pain, infection, and swelling around the implant site but most common is iatrogenic contact to the root of the proximal tooth.^{11,12}

The alternative for implant is to use modifications in conventional anchorage. One of the methods of modifying conventional anchorage is by using a soldered power arm on 1st molar.^{13,14} 2nd molar can also be included to augment anchorage. Whenever there is a requirement of high anchorage both these procedures can be combined. Simultaneous retraction with the intrusion of maxillary anterior via en-mass retraction provides better results. But the maintenance of the canine's axial & angular angle is a must. The direction of the force can lead to the unwanted rotation of maxillary canine, which decreases the rate of retraction.^{15,16} So the axial & angular inclination of maxillary canine must be evaluated pre & post retraction.

So, the present study was designed to evaluate angular changes of maxillary canine between modified conventional

anchorage with a power arm and titanium mini-implant anchorage in en masse retraction.

METHODS

In this study, convenience sampling technique was utilised for selection of participants. A split mouth randomised clinical study was planned. The duration of the study was 10 months from Mar-2014 to Nov-2014. All participants or guardians had been informed about the purpose of the study and signed information & consent form were obtained. A total of 15 subjects were chosen as per inclusive & exclusive criteria & treated with 0.022 MBT pre-adjusted edgewise appliance.¹ The inclusion criteria consisted of participants with bimaxillary dental protrusion or Angle Class II Division I malocclusion with severe overjet requiring group A anchorage.

The exclusion criteria comprised of any developmental anomalies or supernumerary tooth, ankylosed molar or anterior teeth, participants with periodontically compromised condition or any missing molar or anterior teeth, and participants with any kind of bone disorder & systemic conditions. The ethical clearance was obtained prior to the start of study.

The selected participants had all the teeth aligned and levelled and ready for the retraction of anterior teeth. The mini-implant (group 1) or modified power arm side (group 2) was selected using the 'coin flip' randomising method. 2nd molars were included in the conventional anchorage. A power arm was prepared from 19-gauge stainless steel wire and soldered to the headgear tube of maxillary 1st molar on the conventional anchorage side. A titanium mini-implant was inserted on the opposite side. The point of force application (150 gm) on both sides was similar and the direction of force was made to pass through the centre of resistance of 1st molar. A nickel titanium (Ni-Ti) coil spring of similar length on either side was used to apply retraction force so that the same amount of force could be applied on both the sides. The records required were study models and orthopantomogram.¹ Two sets of records were taken. The first records were taken after levelling and alignment, before retraction and another record was taken after all the extraction space was completely closed.

Type of Tooth Movement in the Canine Region

Evaluation of canine rotation (axial) was assessed on the study model. The study models were scanned and calibrated. The method given by Ziengler and Ingervall had been followed. Palatine raphe (or median raphe) was used to construct a median reference line.^{7,17} The mid palatal raphe is a stable landmark. The angle formed between a line through the distal and mesial contact points of the canine and the mid palatine raphae was measured pre- and post-retraction. The comparison was done for their respective sides for pre & post retraction stages.

Evaluation of Canine Angulation from OPG

Canine angulation was assessed from OPG. Infraorbital plane was traced on the orthopantomogram and a long axis of the

tooth is drawn.¹⁸ The angle between these two lines was measured in both pre-retraction as well as post retraction orthopantomogram. Pre-treatment and post-treatment values were compared to their respective sides.

Statistical Analysis

The observations of the study were recorded in the Microsoft Excel sheet and subjected to statistical analysis with IBM SPSS version (24.0) software. The data obtained post retraction were subjected to statistical analysis. Means, standard deviations, and standard errors were tabulated. Student t-test was used to determine the level of significance and correlation of the anchor loss and rate of canine retraction between mini-implant anchorage and modified conventional anchorage with power arm anchorage.

RESULTS

Total number of participants were 15. The mean age of the patient was (18.5 ± 2.3 years; range 8 female, 7 male). All radiographs were exposed with standardised settings.

Measurement of Types of Tooth Movement

Group	Mean	N	Std. Deviation	Std. Error Mean	Mean Difference	P Value
On mini-implant anchorage side-pre	142.333	15	2.468853599	0.637	-9.86667	0.001*
On mini-implant anchorage side-post	152.2	15	2.65114	0.688		
On modified conventional anchorage side with power arm-pre	144.333	15	4.186144948	0.742	-9	0.001*
On modified conventional anchorage side with power arm-post	153.533	15	3.642343568	0.685		

Table 1. Canine Rotation Measured on Study Model

*The difference is significant if P value is < 0.05

On Mini-Implant Anchorage Side

The mean angular pre-retraction angle is measured between the line passing through the distal and mesial contact points of the canine & mid palatine raphe. The mean angular pre-retraction angle was 142.33°. The range of this angle was from 139.86° to 144.79°. The mean angular post-retraction angle was 152.2°. The range of this angle was 149.55° to 154.85°. The difference between pre & post retraction angulations was observed to be 10° (Table 1) suggesting a significant disto-palatal rotation (P = 0.001).

On Modified Conventional Anchorage with Power Arm Side

Similarly, the mean angular pre-retraction angle was 144.33°. The range of this angle was from 140.18° to 148.5°. The mean angular post-retraction angle was 153.53°. The range of this angle was 149.89° to 157.17°. The difference between pre & post retraction angulations was 9° (Table 1) suggesting a significant disto-palatal rotation (P = 0.001).

Group	Mean	N	Std. Deviation	Std. Error Mean	Mean Difference	P Value
On the mini-implant anchorage side	9.86667	15	1.187233679	0.306542418	0.8667	0.666666
On modified conventional anchorage side with power arm	9	15	1.567527626	0.404733893		

Table 2. Comparison of Canine Rotation between the Two Groups on Dental Cast

*The difference is significant if P value is < 0.05

The mean difference in canine angulations after retraction was 9.866° on mini-implant anchorage side. The range for this angle was 8.68° to 11.04°. The mean difference in canine angulations after retraction was 9° on a modified conventional anchorage side. The range for this angle was 7.44° to 10.56°. The mean difference between the two groups was 0.8667° as shown in Table 2. No evident statistically significant difference was observed between the two groups. (P = 0.666666)

Group	Mean	N	Std. Deviation	Std. Error Mean	Mean Difference	P Value
On mini-implant anchorage side-pre	87.7333	15	3.614784456	0.93333218	-0.93	0.481
On mini-implant anchorage side-post	88.6667	15	3.533849917	0.91243589		
On modified conventional anchorage side with power arm-pre	87.8	15	1.624221425	0.419	-1.13	0.088
On modified conventional anchorage side with power arm-post	88.8667	15	1.88	0.485		

Table 3. Canine Angulations Measured on OPG

*The difference is significant if P value is < 0.05

On Mini-Implant Anchorage Side

The mean angle was measured between the infraorbital plane and long axis of the canine on orthopantomogram.¹⁸ The mean pre-retraction angle was 87.73°. The range of this angle was from 84.1° to 91.3°. The mean angular post-retraction angle was 88.66°. The range of this angle was 85.13° to 92.1°. The difference between pre & post retraction angulations was 0.93° (Table 3) suggesting a statistically & clinically insignificant distal tipping of canine tooth (P = 0.481).

On Modified Conventional Anchorage with Power Arm Side

Similarly, the mean pre-retraction angle was 87.8°. The range of this angle was from 86.18° to 89.42°. The mean angular post-retraction angle was 88.86°. The range of this angle was 88.98° to 90.74°. The difference between pre & post retraction angulations was 1.13° (Table 3) suggesting a statistically & clinically in significant distal tipping of canine tooth.

Group	Mean	N	Std. Deviation	Std. Error Mean	Mean Difference	P Value
On the mini-implant anchorage side	0.93333	15	0.677881	0.17502	0.07	0.7861
On modified conventional anchorage side with a power arm	1	15	0.65465	0.16902		

Table 4. Comparison of Canine Angulations between the Two Groups on OPG

*The difference is significant if P value is < 0.05

The mean difference in canine angulations after retraction was 0.93° on the mini-implant anchorage side. The range for this angle was 0.26° to 1.6°. The mean difference in canine angulations after retraction was 1° on a modified conventional anchorage side. The range for this angle was 0.35° to 1.65°. The mean difference between the two groups was 0.66° (Table 4). No evident statistically significant difference was found between the two groups. (P = 0.786)

Graph 2. Comparison of Canine Angulations between the Two Groups as Measured on OPG

DISCUSSION

The type of tooth movement depends on the direction of force application and force exerted. Retraction of the canine with a force labial to its center of resistance will cause a tendency for the tooth to rotate disto-palatally.

The maxillary anterior teeth were bodily retracted against mini-screw implants & modified power arm. The centre of resistance of the six anterior teeth was estimated to be halfway between the centre of resistance of the four incisors and canines. By using an upward and backward force passing near the centre of resistance, the maxillary anterior teeth showed bodily intrusion and retraction.¹⁹

The slight rotation which occurred might be related to the play between the archwire and slot of the bracket, flexibility of stainless steel archwire, and ligatures used.¹⁶

Matasa⁹ and Daniel¹⁵ used different bracket designs and they found an increasing tendency towards distal rotation or buccal root torque were recorded, because of the play of wire inside the bracket slot and the type of ligation. The canine center of resistance theoretically is located on the long axis of the tooth, but the point of force application was buccal or labial to the long axis. The tooth usually rotates out to the labial aspect to a greater arch radius as the canine moves distally. In the present study, 10° of disto-palatal rotation was observed in the study model on the mini-implant anchorage side. The change in canine angulations after the en-masse retraction was 0.93° & 1.13° for mini-implant & modified conventional molar anchorage with the power arm side respectively. The change in canine angulation in relation to the long axis was not exceeding to the normal range.¹⁶ The probable reason was heavy archwire (0.19 X 0.25 ss) which expresses the torque efficiently. Another reason was the force being applied to the archwire through the crimpable hook. This will try to slide the wire in bracket slot without causing more rotation.

CONCLUSIONS

A disto palatal rotation and distal tipping of canine were observed among both the groups which were not clinically and statistically significant. Type of anchorage reinforcement did not influence the angulation of canine in the transverse and sagittal direction. The mini-implants inserted in the interdental bone between the maxillary first molar and second premolar proved to be efficient for intraoral anchorage for the en masse retraction of the maxillary anterior teeth. There was no difference in the type of tooth movement during retraction by mini-implant and power arm.

Data sharing statement provided by the authors is available with the full text of this article at jemds.com.

Financial or other competing interests: None.

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