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Comparison of canine retraction by conventional and corticotomy-facilitated methods: A split mouth clinical study

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Abstract:

OBJECTIVE: The purpose of this split-mouth single-centered, parallel-group, randomized clinical trial was to evaluate the efficiency of corticotomy-facilitated orthodontics in rapid canine retraction.

METHODS: The sample consisted of 10 patients (15–25 years old) requiring extraction of the maxillary first premolars with subsequent canine retraction. The patients' right sides were randomly assigned to either the corticotomy (experimental) or control groups. Corticotomy cuts and perforations were performed and canine retraction was initiated bilaterally with closed-coil nickel-titanium springs that applied 150 g of force. The following variables were examined till the end of canine retraction on both sides: Rate of canine retraction, canine root resorption, and patient perception of the procedure. The rate of canine retraction was assessed every month using study models while root resorption was evaluated using CBCT. Patient`s perception was evaluated using a 100 mm VAS.

RESULT: Mean time taken for full completion of canine retraction: 5.7 months (test) and 7.1 months (control). Mean root resorption: 0.53 ± 0.10 (control) and 0.24 mm ± 0.10 (test). Mean VAS scores: 16 ± 3.94 (24 hours) and 2 ± 2.58 (1 week) at control side and 46.50 ± 6.69 (24 hours) and 2 ± 2.58 (1 week) at test.

CONCLUSION: There was an overall reduction in the time taken for canine retraction with corticotomy; however, an increase in the rate of canine retraction in the corticotomy-facilitated method was evident only for the first four months, compared to the conventional method. Less root resorption was observed in corticotomy-facilitated method than conventional method. Pain perception was more for corticotomy-facilitated method than conventional method at 24 hours, but similar after one week.

Keywords:

Accelerated orthodontics, retraction, resorption, pain

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Introduction

The fear of pain and long treatment duration are two of the most important factors responsible for dissuading patients from taking orthodontic treatment. It should also be aimed that time dependent adverse events such as discomfort, pain, external apical root resorption, suboptimal oral hygiene, white spot lesions and dental caries are held to the minimum.[1] According to Wishney M,[2] the risk of root resorption and incidence of white spot lesions increases with treatment time. Hence, a reduced duration of treatment is important for orthodontists as well as their patients.

A wide range of novel techniques have been introduced to accelerate orthodontic tooth movement. These techniques can be generally divided as surgical and non-surgical. Non-surgical techniques that have been studied are low-intensity laser

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irradiation, resonance vibration, pulsed electromagnetic field, electrical currents, and pharmacological approaches.

The surgical category comprises of alveolar corticotomy, distraction of the periodontal ligament and distraction of the dento-alveolus. Corticotomy or decortication implies to the intentional cutting of cortical bone. It has been claimed that the technique dramatically shortens treatment time by eliminating dense cortical bone resistance to orthodontic tooth movement. This diminished resistance was explained by the underlying regional acceleration phenomenon (RAP) occurring after a wound. RAP involves the recruitment of osteoclasts and osteoblasts at the injured site for wound healing, resulting in a transient localized phenomenon of demineralization/remineralization in the bony alveolar enclosure. In addition, corticotomy-assisted orthodontics has been found to reduce the undesirable side effects of orthodontic treatment, including root resorption and periodontal damage.[3]

Mathews and Kokich[4] have questioned the efficiency of this procedure due to the short duration of the regional acceleratory phenomenon, the significant additional expense and the lack of evidence of a significant reduction in orthodontic treatment time. Several case reports, narrative reviews and clinical research reports have discussed various aspects of the techniques used for accelerated orthodontic tooth movement, but no specific conclusions have been drawn on some variables of this technique.[1]

The aim of this study was to compare corticotomy-facilitated canine retraction with conventional mechanics in terms of rate of canine retraction, amount of root resorption, and patient perception.

Materials and Method

This was a single-centered, parallel-group, randomized clinical trial with 1:1 allocation ratio, performed at I.T.S. Center for Dental Studies and Research, Muradnagar. Type I error frequency of 5% and the power of the Statistical test set at 80% (P = 0.9, β = 0.1) using previous study[3] as a guide to detect at least a 0.5 mm difference in the rate of tooth movement was used in determining the sample size. Based on this, the sample size came out to be 8, but to consider potential dropouts; we included 10 patients in each group. Ethical grant for the study was provided by the Institutional Ethical Committee (Ethical Committee Approval Number was ITSCDSR/L/2018/149). 10 patients requiring fixed orthodontic treatment were selected to participate in the study according to the following inclusion criteria: Age ranging from 18 to 25 years, cases requiring extraction of upper 1st premolars, full complement of permanent teeth up to 2nd molars, probing depth less than 4 mm in all teeth, gingival and plaque index less than or equal to 1. Exclusion Criteria included long-term use of antibiotics, phenytoin, cyclosporin, anti-inflammatory drugs, systemic corticosteroids, and calcium channel blockers, poor oral hygiene, systemic diseases, evidence of bone loss, periodontal disease, smoking, and probing depth more than 4 mm in any tooth.

Prior to the study, the research goals, intervention methods, and probable risks and benefits were explained to the participants, the confidentiality of any disclosed information was guaranteed, and voluntary participation was emphasized. Written informed consent was obtained from all the participants.

Method

Fixed appliance with MBT (0.022″ × 0.028″) prescription (Victory Series, 3M-Unitek, United States) was placed in all the patients. Starting phase of leveling and alignment was completed and routine arch wire sequence was followed till placement of 0.018″ stainless steel wire (3M-Unitek, United States).

Type of randomization was simple and computer-generated random numbers were generated using Microsoft Office Excel 2007 sheet by a person who was not involved in the clinical trial. The patients' right sides were randomly assigned to either the corticotomy (experimental) or control groups. The numbers of the subjects were kept in opaque sealed envelopes until the commencement of canine retraction. On the day of corticotomy procedure, subjects were allowed to choose one of the envelopes to detect their number in the randomization sequence and thus detect which was the corticotomy side.

Corticotomy method

Incisions were made from the mesial surface of the maxillary lateral incisor to the mesial surface of the maxillary second premolar and full thickness mucoperiosteal flap was raised. A submarginal flap was used, where the incision was performed 4 mm apical to the free gingival margin to preserve the papilla.[3] A number 2 round bur was used for bone drilling and vertical corticotomy cuts or perforations were performed in the area of interest, 2 mm below the alveolar crest to preserve the crestal bone and was then extended to the entire length of the canine root. This was followed by graft placement (Tissue Bank, Tata Memorial Hospital, Mumbai) and secured closure.[5] [Figures 1-4]

Nance palatal arch was used to hold the molars and 0.018-in stainless steel wire was placed 2-3 days post-surgery. Nickel titanium closed-coin springs (150 gm of force) (GC Orthodontics, Illinois, United States)

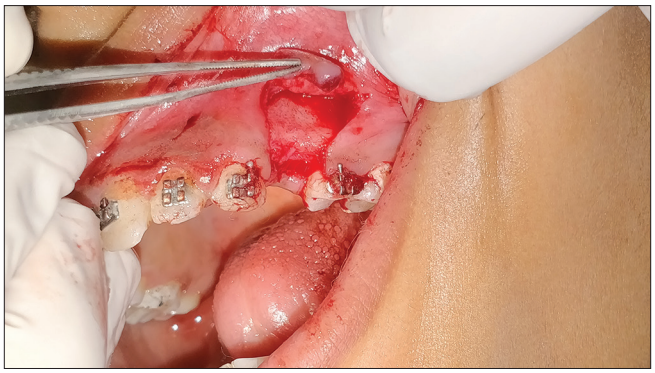

Figure 1: Flap Reflection

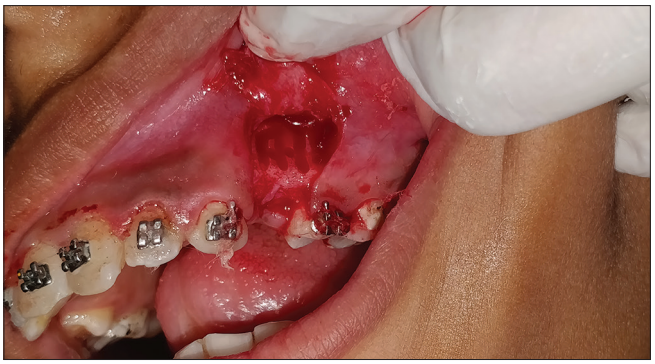

Figure 2: Corticotomy cuts and perforations distal to canine

Figure 3: Demineralized freeze-dried bone graft placed over the corticotomy area

Figure 4: Flap secured in place with sutures

on each side were used for canine retraction. The coil springs were extended between the canine and the molar tube hooks where the maxillary 1st molar and 2nd premolar were ligated together and designated as the anchor unit. [Figure 5].

Measurement of canine retraction

To monitor the rate of tooth movement, alginate impressions were taken immediately before corticotomy procedure, 28 days after canine retraction began and subsequently each month till the completion of canine. The impressions were immediately poured up with stone plaster. Vertical lines were drawn on the cast over the palatal surface of the canine from the middle of the incisal edge to the middle of the cervical line. The distance between the canine and the lateral incisor was assessed before and after canine retraction. All measurements on the cast were made using digital calipers with an accuracy of 0.01 mm. [Figure 6]. Study done by Choi *et al*.[6] suggest that the number of palatal rugae vary greatly in individuals, and that this affects the anteroposterior position of the 3rd primary palatal ruga. Therefore, when superimposing digital models, this discrepancy needs to be considered when determining the suitability of using the 3rd primary ruga as a reference area. When the 3rd primary ruga is located anteriorly, care should be taken when using it as a reference area for superimposition with a digital model before and after orthodontic treatment. Since the practical efficiency and clinical applicability of measuring rate by directly drawing lines on cast was more and cost effective than digital scanning of study models, it was used in this study.

Both intra-observer and inter-observer errors were evaluated. For the evaluation of the intra-observer error, 10 models were measured twice at least 2 weeks later. For the inter-observer error, a second investigator (S.A.) measured the same set of models twice, and the difference was calculated.[7]

Canine root resorption

The change in the root length before and after retraction on both sides assessed through CBCT was used to determine the amount of root resorption.[4] New Tom Giano Extra-Oral Imaging System (Newtom – Giano, Vila Silverstrini, Verona, Italy) (high frequency, stationary anode: 60–90 kV; 1–10 mA, pulsed mode 0.5 mm focal spot) was used. The final scan was taken at 90 kV at a resolution of 200 microns or 0.2 mm

at a field of view (FOV) of 5 × 8 cm. After the acquisition, each tooth was individually localized in the MPR view in all three orthogonal planes, that is, axial, coronal, and sagittal. To analyze root resorption, measurements were made in sagittal section using NNT software. Reference points for the measurements were cusp tip and root apex of maxillary canines in mid-sagittal section. Maximum linear length between cusp tip and root apex of canines was measured using axial multiplanar reconstruction at 0.25-mm isometric voxel by one examiner blinded to the side on which corticotomy was done. [Figure 7]

Assessment of pain

The participants were asked to evaluate their level of discomfort at 24 hours and 7 days after the beginning of canine retraction on a VAS.[7] All the patients were prescribed routine pain medication, twice a day, for a period of 48 hours from the time of corticotomy and they were compliant with respect to the medication.

Results

The data were checked for statistical analysis using SPSS (Statistical Package for Social Sciences) version 20.0 statistical analysis software. The descriptive statistics along with the mean, standard deviation, minimum, and maximum values were calculated for each of the variables in both groups. A repeated measure ANOVA was used to compare the rate of canine retraction between corticotomy-facilitated and conventional mechanics group followed by post hoc Tukey test. Mann Whitney U test was used to compare the VAS scores between the groups. Wilcoxon signed rank test was used to compare scores at 24 hours and 1 week in the two wires. The root resorption in canines between both groups was compared using student's t test. The significance was set at $P < 0.05$.

Method error was determined using Intra class Correlation Coefficient and was found to be high (0.89). Table 1 shows the mean canine retraction rates for both the groups. The rate of canine retraction decreased through the time intervals, highest being at T0-T1 (0.81 ± 0.06 mm for control and 1.36 ± 0.33 mm for test group) and lowest at T7-T8 (0.10 ± 0.22 mm for control and 0.00 mm for test group). Additionally, test site values were greater than control site values till time interval T3-T4, after which test site values became lower than control site.

Canine retraction at test and control sites was analyzed over 9 time intervals using two way RMANOVA [Table 2]. Results showed that canine retraction rate was significantly different across the time intervals [Figure 8]. The categories i.e., test and control sites had no significant impact on canine retraction, hence no post hoc test was done for the same. However, when both variables were considered together, they significantly affected canine retraction. Post hoc test shows that the different rates

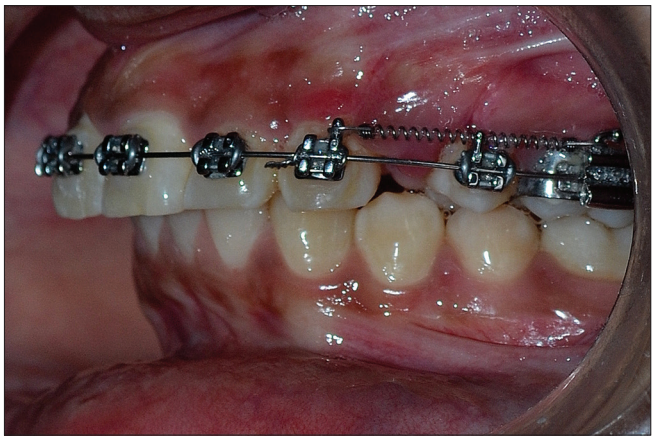

Figure 5: Closed Coil NiTi Coil Springs stretched between canine hooks and buccal tube hooks on first molars

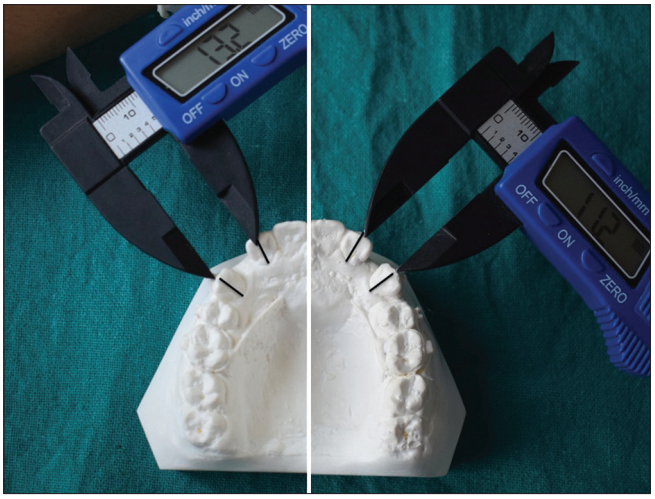

Figure 6: Measurement of distance between canine and lateral incisor on both sides with a digital vernier caliper

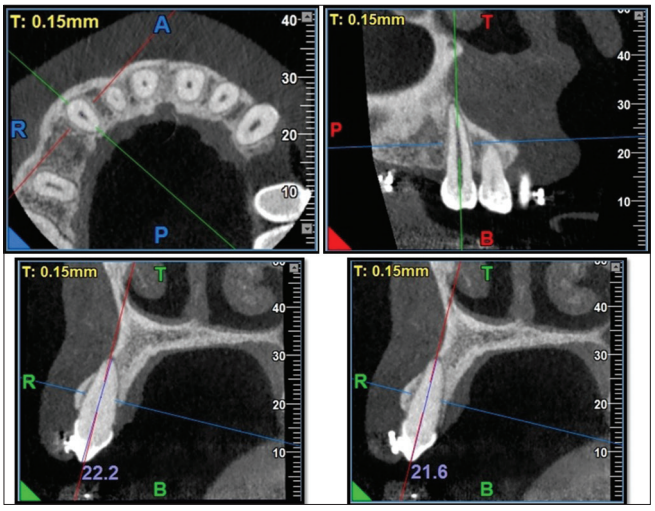

Figure 7: Axial-guided navigation and measurement of root lengths on sagittal section of CBCT

Table 1: Descriptive statistics for rates of canine retraction at test and control sites over the study time period

Time Interval	Category	Mean (in mm)	SD (in mm)	*n*	95% Confidence Interval	
					Upper bound	Lower bound
T0-T1	Control	0.81	0.06	10	0.77	0.85
	Test	1.36	0.33	10	1.77	0.95
T1-T2	Control	0.74	0.08	10	0.69	0.79
	Test	0.93	0.22	10	1.20	0.66
T2-T3	Control	0.75	0.10	10	0.69	0.81
	Test	0.79	0.07	10	0.88	0.70
T3-T4	Control	0.69	0.06	10	0.65	0.73
	Test	0.72	0.08	10	0.82	0.62
T4-T5	Control	0.70	0.07	10	0.66	0.74
	Test	0.61	0.22	10	0.89	0.33
T5-T6	Control	0.64	0.07	10	0.60	0.68
	Test	0.43	0.31	10	0.81	0.05
T6-T7	Control	0.49	0.22	10	0.35	0.63
	Test	0.07	0.22	10	0.34	-0.20
T7-T8	Control	0.10	0.22	10	-0.03	0.23
	Test	0.00	0.00	10	0.00	0.00

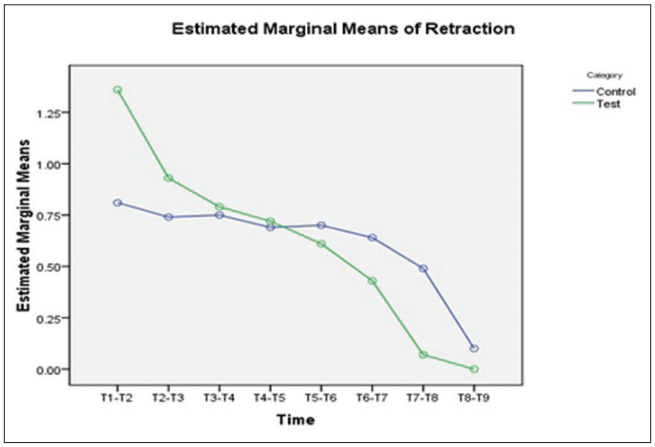

Figure 8: Estimated marginal means of retraction at different time points showing increased rate of retraction on test side till T4-T5 than control side

of canine retraction was highly significant across all intervals except when comparing T1-T2 with T2-T3, T3-T4 respectively followed by between T2-T3 and T3-T4, T4-T5, respectively and lastly between T4-T5 and T3-T4, and T5-T6 intervals respectively. Student t-test was applied to compare rate of canine retraction between control and test sites during each time interval. The difference between retraction at control and test sites were statistically significant at T0-T1, T1-T2, and T6-T7 intervals, respectively.

Mean root resorption in the two groups was compared using student t-test. It was greater in control group (0.53 mm) than test site (0.24 mm) and the difference was statistically significant, $P < 0.05$ [Table 3]. Since the VAS gives ordinal data, non-parametric Mann Whitney U test was applied to compare the VAS scores 24 hours and 1 week after treatment for both test and control sites. The pain perception 24 hours after treatment was greater at

Table 2: Comparison of rate of canine retraction using two way repeated measures ANOVA

Dependent Variable: Retraction			Mean Square	*F*	Sig[a]
Source	Type III Sum of Squares	Df			
Time	14.82	7	2.12	68.64	0.00**
Category	0.0001	1	0.00	0.00	0.96
Time* Category	2.90	7	0.41	13.43	0.00**

Table 3: Comparison of root resorption between test side and control side

Group	Mean (in mm)	SD (in mm)	*n*	95% Confidence interval		*t* value	Sig
				Upper bound	Upper bound		
Control	0.53	0.10	10	0.59	0.47	0.68	0.00
Test	0.24	0.10	10	0.36	0.12		

test sites as compared to control sites and the difference was found to be statistically significant [Table 4].

Discussion

Canine retraction at test and control sites was analyzed over 9 time intervals starting from T0 i.e., just before corticotomy, T1 was 1 month after corticotomy and so on till T9, using two way RM-ANOVA. The results of our study showed that canine retraction rate at test site was greater than control site till interval T3-T4 (4th month), but the difference was statistically significant only till T2. Rate of canine retraction on test site was 1.6 times faster for 1st month and 1.2 times faster for 2nd month. These findings agree with those of Wilcko *et al*.[8] Lino *et al*.[9] Ren *et al*.[10] and Moon *et al*.[11] who reported that tooth movement velocity was more on the corticotomy side than on the control side.

Table 4: Comparison between VAS scores at 24 hours and 1 week after treatment using Mann Whitney U test

	Group	*n*	Mean Rank	Sum of Ranks	Sig
24 hours	Control	10	5.5	55	0.00
	Test	10	15.5	155	
1 week	Control	10	10.3	103	0.91
	Test	10	10.7	107	

The results of our study showed an increase in the rate of canine retraction on the test side till T3-T4 (4th month) which was in agreement with previous studies. However the follow-up period of these studies was limited to a maximum of four months while the present study continued till the end of canine retraction. The mean time for full completion of canine retraction on test site was 5.7 months while it was 7.1 months for the control site showing an overall decrease in duration when using corticotomy facilitated method. The rate of retraction showed a drop after T3-T4 stage resulting in a similar rate on both the sides thereafter. At the later stages of tooth movement, the mean rate of retraction appeared to be greater on the control site because the canine retraction had already been completed in some patients on the test site. This resulted in a lower mean value of rate of canine retraction on the test site. The drop in the rate of canine retraction at later stages may be explained on the transient nature of the regional acceleratory phenomenon.

Suryavanshi[12] recorded the effect of a modified corticotomy technique till the full completion of canine retraction and showed that there was a statistically significant increase in rate of canine retraction on the corticotomy side; although the method used to measure the rate of retraction and whether or not there was an overall reduction in treatment time was not mentioned.

Root resorption is still a major clinical problem in orthodontics. Few authors have investigated whether accelerated tooth movement and decortication have an impact on root resorption.[13] The results of our study showed that the test side showed statistically significant less root resorption than the control side. This is in agreement with the findings of Generson *et al*.[14] Suya,[15] Hatrom *et al*.[16] Wilcko and Wilcko,[8] and Moon *et al*.[11] who reported that teeth retain their vitality without any evidence of resorption after corticotomy surgery. Alamadi *et al*.[17] did a comparison of cone beam computed tomography and conventional 2D radiography in diagnosing the amount of root resorption and concluded that CBCT is a more accurate technique when measuring root length and detecting the amount of root resorption; hence, CBCT was used in our study.

The fear of surgery and the related morbidity resulting in pain and discomfort may in fact discourage patients from considering it as a treatment option. Ziwawi[18] found that the embracing of corticotomy-assisted orthodontics as a treatment option was low among patients. Fear from the surgery was the most important reason for patients not selecting it. It was a questionnaire-based study on patients that did not actually undergo corticotomy. Therefore, our study also assessed patients' acceptance of corticotomy-assisted orthodontics by measuring VAS scores 24 hours and 7 days after the procedure. Mean VAS scores in our study indicated that pain perception was higher at test sites at 24 hours but were similar at 1 week after corticotomy compared to control site.

The limitation of this study was the small sample size comprising majorly of females which could have had an effect on pain perception and the amount of root resorption.

Conclusions

- There was an overall reduction in the time taken for canine retraction with corticotomy; however, an increase in the rate of canine retraction in the corticotomy-facilitated method was evident only for the first four months, compared to the conventional method.
- Less root resorption was observed in corticotomy-facilitated method than conventional method.
- Pain perception was more for corticotomy-facilitated method than conventional method at 24 hours, but similar after one week.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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