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Pulp Vitality of Orthodontic Retracted Canine Using Two Approaches of Periodontal Distraction: A Comparative Clinical Study

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Abstract

***Objectives*:** All studies performed periodontal distraction with interseptal bone cuts but no one performed it without interseptal bone cuts. Therefore the aim of the present study was to evaluate and compare the effect of periodontal distractor with and without interseptal bone cuts on the pulp vitality of the retracted canines. ***Methods*:** The sample of the study consisted of 32 canines in 16 female patients (16- 21 years old) requiring extraction of bilateral maxillary first premolars and canine retraction. They were divided into two groups: canine retraction by periodontal distractor with distal interseptal bone cuts (Group I), canine retraction by periodontal distractor without distal interseptal bone cuts (Group II). After bilateral maxillary premolar extraction in both groups inter septal bone cuts was done in group I only. Then the periodontal distractor was cemented and activated twice per day in both groups. An electrical vitality test was evaluated before and after the distraction procedure. ***Results*:** None of the teeth reacted negatively to the electrical vitality test that was performed one month after the completion of the distraction procedure. There was no clinical sign of discoloration or pulpal pain in any tooth. ***Conclusions*:** Canine retraction was accelerated effectively by periodontal distraction technique either with or without distal interseptal bone cuts. The electrical pulp tester was positive in both groups.

Keywords: Canine retraction, distraction osteogenesis, periodontal distractor, pulp vitality.

INTRODUCTION

One of the most commonly used procedures in orthodontics is the retraction of canines into the space created by the extraction of first premolars. Conventional methods of canine retraction are generally grouped into frictional and frictionless mechanics [1].

Long duration of fixed orthodontic treatment, which usually lasts for 2-3 years, is accompanied by side effects such as root resorption, gingival inflammation and dental caries [2, 3]. Orthodontic research has always been focused on the development of faster and more effective tooth movement [1].

Different methods for accelerating orthodontic tooth movement have been described recently. These methods can be grouped into three groups: Drugs (prostaglandins [4], interleukins [5], leukotrienes [6], platelet rich plasma [7], and vitamin D [8]), Mechanical or physical stimulation (direct electrical current [9], pulsed electromagnetic field [10], low-energy laser [11], and vibration [12]), Oral surgical methods that accelerate orthodontic treatment due to disruption of alveolar bone continuity, or induction of localized inflammatory reaction, which in turn activates osteoclastic activity [13]. Also, surgery in the alveolar bone resulted in its injury with subsequent decrease in its bone density thus decreasing its resistance to orthodontic tooth movement [14, 15].

Surgical methods including osteoperforation [16], corticotomy [17], and distraction osteogenesis [18].

Distraction osteogenesis is one of the surgical procedures that used to accelerate the rate of tooth movement through inducing new bone formation by applying mechanical strains on the bone. The formation of new bone is achieved through stretching of the callus in the osteotomy or corticotomy gap with distraction devices [19].

There are two techniques of distraction osteogenesis known as dentoalveolar distraction (DAD) [20] and periodontal ligament distraction (PLD) which is similar to that of the midpalatal suture during rapid palatal expansion performed for crossbite correction [21].

No previous study has performed on periodontal distractor without interseptal bone cuts. Therefore, the aim of this study was to evaluate and compare pulp vitality of retracted maxillary canine via periodontal distractor with interseptal bone cuts and periodontal distractor without interseptal bone cuts.

Null Hypothesis

The null hypothesis will be that the effect of periodontal distractor with interseptal bone cuts on maxillary canine retraction equal to periodontal distractor without interseptal bone cuts.

METHODS

Patient Selection

A total of 16 female patients (32 canines) who need extraction of maxillary first premolars followed by canine retraction aged 16-21 years old were used in this study. These patients were selected from those attending at the orthodontic clinic, Faculty of Dental Medicine for Girls, Al Azhar University (Girls' Branch). The research proposal was approved by the Research Ethics Committee (REC) of Faculty of Dental Medicine for girls, Al-Azhar University with code (ORTHO-108-6-n). All patients have signed on written informed consent before treatment illustrated all steps in details.

Sample Size Calculation

Minimum sample size was calculated to be 7 patients (14 canines) in each group according to aprevious study by Kumar *et al.,* [22] assuming the mean distraction procedure was completed in 14.60 ± 1.536. To increase the reliability of the results and overcome any possibility of dropping out of patients, each group has 8 patients (16 canines) (Fig. 1).

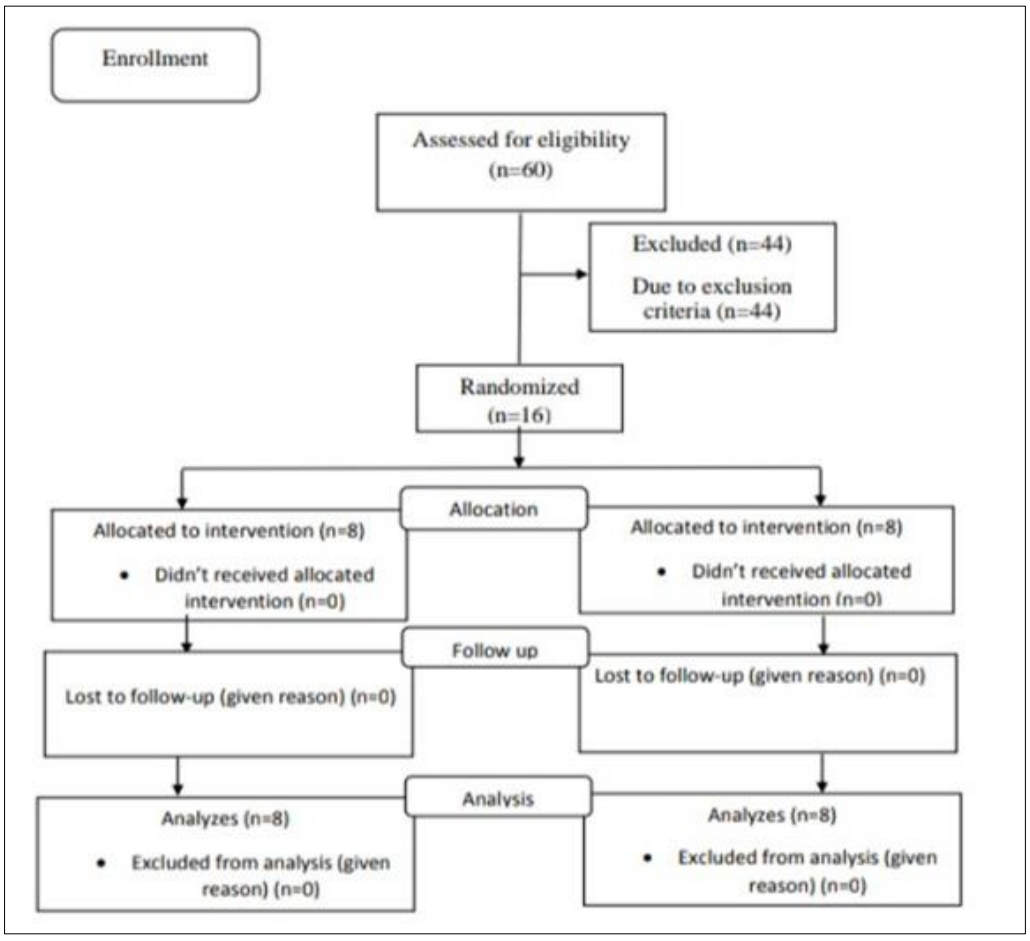

Fig. 1: Flow diagram of the study

Randomization and Group Allocation

Sample randomization was conducted with the aid of online research randomizer [23]. Numbers were from 1 to 16 and each group contained 8 numbers. Number 1 was falled in periodontal distractor with intersptal bone cuts group. Number 2 was falled in periodontal distractor without intersptal bone cuts group and so on.

Allocation concealment was achieved using opaque, sealed envelopes. Randomization and allocation concealment were performed by one of the academic stuff who was not involved in the study.

The patients were equally and randomly divided into 2 groups. 8 patients (16 canines) for each one:

1. **Group I:** Canine retraction by buccal periodontal distractor on both sides with vertical and oblique cuts of interseptal bone distal to canine.
2. **Group II:** Canine retraction by buccal periodontal distractor on both sides without undermining interseptal bone distal to canine.

Inclusion criteria

1- Patient age 16-21 years,
2- patients required bilateral extraction of maxillary first premolars followed by maxillary canine retraction (class I malocclusion as excessive overjet, bimaxillary protrusion, class II malocclusion),
3- The dentition didn't exhibit any gross anatomic root anomalies as assessed from panoramic radiographs,
4- No systemic disease that may affects the bone,
5- No periodontal disease,
6- Good oral hygiene,
7- Very good patient compliance,
8- Absence of any previous orthodontic treatment.

Exclusion criteria

1- The dentition exhibit any gross anatomic root anomalies as assessed from panoramic radiographs,
2- Cases with deep carious lesions or endodontic lesions involving the maxillary canines and buccal segments,
3- Cases with severly rotated or grossly malpositioned canines,
4- Systemic disease that may affects the bone,
5- Periodontal disease and poor oral hygiene,
6- Presence of previous orthodontic treatment.

Intervention Procedure

Patient Records

Case history, clinical examination, panoramic radiograph, standardized lateral cephalometric radiograph, standarized intra-oral and extra-oral photograph, orthodontic study model, digital periapical radiograph for maxillary canines and electric pulp testing for maxillary canines were taken before and after treatment.

Surgical Procedure

Under local anesthesia, maxillary first premolars were extracted in two groups without squeezing for the socket.

In group I, the interseptal bone distal to the canine was undermined with asurgical bone bur which used in low speed straight hand-piece with adequate cooling water jet, grooving vertically with 45^{o} inside the extraction socket, along the buccal and palatal sides, and extending obliquely toward the base of the interseptal bone to weaken its resistance under saline irrigation. The depth of the undermining grooves was dependent on the thickness of the interseptal bone as revealed on the digital periapical film [24] (Fig. 2). In group II, interseptal bone cuts don't performed.

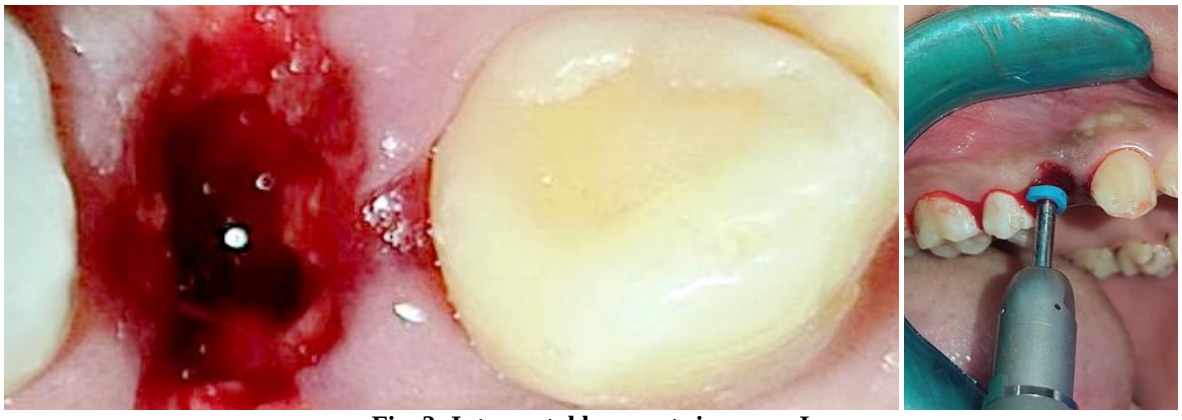

Fig. 2: Interseptal bone cuts in group I

Distractor Construction in Group I, II

Bands of the first molars and the canines were adapted on the dental cast. A custom-made intraoral distraction device was fabricated from a HYRAX expander which was trimmed, ground, and polished. Then it was opened an amount equal to the mesio-distal width of the maxillary first premolar to be extracted.

It was adapted on to the patient's dental cast and soldering was completed on to the bands of the

maxillary first molars and the canines [25] (Fig. 3). Then it was cemented in patient's mouth. Power chains were placed on the lingual side between the maxillary canine and the first molar to prevent rotation of the canine during distraction.

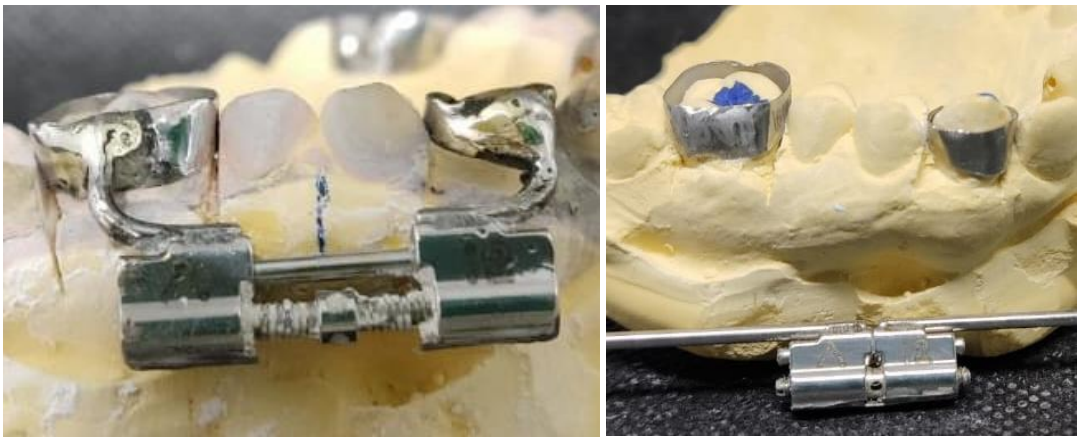

Fig. 3: Construction of custom-made periodontal distractor

Activation Protocol

In group I and II, the distraction was initiated immediately in the same day of extraction of maxillary first premolars. An advancement of 0.25 mm was performed two times per day [26] and the patient seen every week till the distal surface of canine became in contact with the mesial surface of second premolar (Fig. 4).

After completion of distraction, the distractor was removed. Then brackets were bonded, and a ligature wire was placed that joined the maxillary canine, second premolar and first molar in both sides. Finally the edgewise mechanics was begun.

Fig. 4: Periodontal distractor before and after retraction.

Measurement of Pulp Vitality

An electrical vitality test was performed before extraction of maxillary first premolars and 1 month after canine distraction procedure with an electronic pulp tester (EPT). After application liduid media on maxillary canine, the probe of the pulp tester was placed on the middle one-third of the buccal enamel surface of the maxillary canine, and the current was increased gradually. Each patient was observed for signs of pain, and then the corresponding number on the scale was registered. The number obtained from the distracted canine was compared with the number obtained from the same canine before placement of distractor [27] (Fig. 5).

Fig. 5: Measurement pulp vitality with electrical pulp tester

Statical Analysis

Comparison between groups was performed by using ANOVA test., followed by Bonferroni post hoc test for pairwise comparisons; whereas Kruskal Wallis test was used for comparison of other non-parametric variables. All p-values are two-sided. P-values ≤0.05 were considered significant.

RESULTS

Mean, standard deviation, minimum and maximum of vitality score before and after retraction in both groups were illustrated in (table 1) and (Fig. 6).

Comparison revealed that the value of vitality score of all retracted canines showed lower values after treatment, in comparison to before treatment but they were still vital before and after the distraction. None of teeth reacted negatively to the electrical vitality test that was performed one month after the completion of the distraction procedure. There was no clinical sign of discoloration or pulpal pain in any tooth.

Regarding the difference in vitality score from before to after distraction, there was no significant difference between group I (median= 2) and group II (median= 1.5) (p=0.335).

Table 1: Descriptive statistics of vitality score and comparison between groups and within the same group

Group		Vitality score		
		Before	After	P#value within group
Group I	Mean	22.88	20.50	
	Standard deviation	4.54	4.31	.000*
	Minimum	14.00	11.00	
	Maximum	30.00	28.00	
Group II	Mean	19.31	17.13	
	Standard deviation	7.58	7.10	.002*
	Minimum	11.00	10.00	
	Maximum	34.00	31.00	
P-value between groups		0.259 ns	0.159 ns	

Significance level p≤0.05, * significant, ns=non-significant.

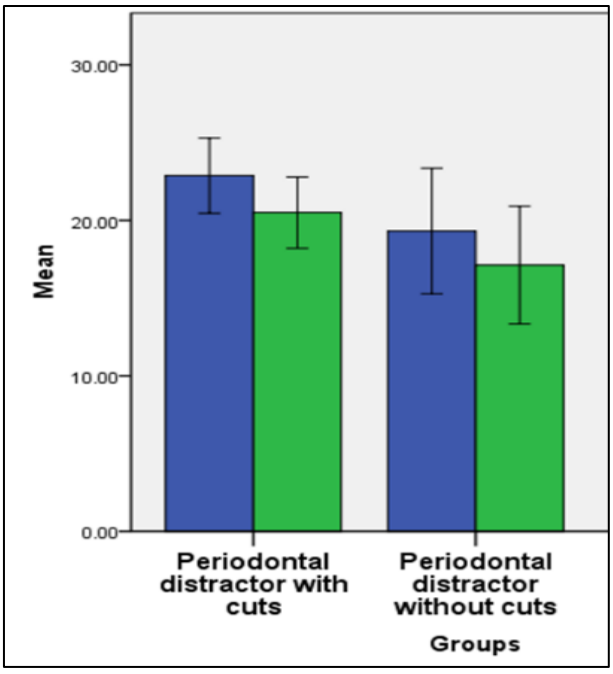

Fig. 6: Bar chart illustrating mean value of vitality score in different groups

DISCUSSION

Conventional orthodontic treatment especially that involves extraction therapy is long treatment time; it may last for about 31 months [27]. Long orthodontic treatment time may resulted in root resorption, gingivitis, and caries [28].

So, recently decreasing treatment time by accelerating the rate of tooth movement considered an aim in orthodontic practice [29]. Several techniques of rapid canine retraction can be used as distraction osteogenesis [30] which accelerates the bone resorption, and osteoclast activity [31].

Most of surgical techniques involve invasive flap surgery; so, a novel simplified flapless approach was performed to accelerate the rate of canine movement by periodontal ligament distraction which was reported as technique not resulted in damage to the periodontal ligament [26].

No previous study was performed on periodontal distractor without interseptal bone cuts. Therefore, the aim of the present study was to evaluate and compare the effects of periodontal distractor with and without interseptal bone cuts on pulp vitality of retracted maxillary canine; as such a comparison has never been performed.

In the present study, the value of vitality score of all retracted canines showed lower values after treatment, in comparison to before treatment but they were still vital before and after the distraction. None of teeth reacted negatively to the electrical vitality test. There was no clinical sign of discoloration or pulpal pain in any tooth. The difference between groups was not statistically significant.

Regarding all canines remain vital in periodontal distractor with and without cuts, this may be due to 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. Hence, the observed tipping of the canines might be an advantage with regard to pulp vitality during rapid tooth movement with both the procedures [24].

In periodontal distractor with cuts, the results of the present study were in consistent with previous studies [24, 32, 33] as they concluded that there was no deterioration in pulp vitality of canine.

In periodontal distractor without cuts group, no previous studies performed on this approach. The results of the present study revealed that there was no significant difference between this group and periodontal distractor with cuts group. This may be due to the distal movement of the canines is a combination of tipping and translation in both groups.

Further investigations of pulp vitality is needed in patients subjected to rapid tooth movement using periodontal distractor without interseptal bone cuts to confirm the results in our study.

Limitations of Study

The study was done on female patients only so, evaluation on both gender are needed. Pulp vitality was performed in short-term period so, long-term assessment of this measurement is required. Electric pulp tester not more reliable method in measuring pulp vitality so, investigation of pulp vitality with more reliable method are required.

CONCLUSION

Within the limitations of this study, it was concluded that periodontal distractor with and without interseptal bone cuts were effective in acceleration of canine retraction. Retracted canines remain vital after retraction in both approaches.

Abbreviations

DAD: Dentoalveolar distraction;
PLD: Periodontal ligament distraction;
EPT: Electric pulp tester.

Acknowledgements: Not applicable.

Author Contributions

AME: Clinical study, analysis of the data and writing of the manuscript. FAH: Supervision of the research project. SAH: Read and approved the final manuscript. MMM: Review the results and manuscript.

Funding: No funding was received from any agency.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

DECLARATIONS

Ethics Approval and Consent to Participate

This study had approval from the ethical committee of Faculty of Dental Medicine for girls, Al-Azhar University with code (ORTHO-108-6-n). All the methods in the study were carried out in accordance with the relevant guidelines and regulations. Informed consent agreement was signed by a parent or guardian for participants.

Consent for Publication: Not applicable.

Competing Interests

The authors declare that they have no competing interests.

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