The Orthodontic Extrusion Movements and the Periodontal Tissues

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Citation

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Abstract

Objective: The aim of this study is to investigate whether orthodontic extrusion movements have negative effects on the periodontal tissues, and to detect the relationship between orthodontic tooth extrusion and the width of the keratinized gingiva.Materials and Methods: Fourteen upper canines of seven patients having different Angle classifications were selected for the study. According to the abnormal position of those canines they were subjected to orthodontic extrusion forces in order to bring them back to a normal level within the dental arch and, therefore, to correct the abnormality. Plaque index, probing depth, gingival index, papillary bleeding index and keratinized gingiva width were measured around the examined canines at baseline, one month, 3 months and 6 months after the initiation of the extrusion movements.Results: The values of plaque index and gingival index increased significantly during the whole period of study, whereas the probing depth and papillary bleeding index values did not show any important differences. A very slight increase in the keratinized gingiva width of about 0.14 mm was detected at the examined teeth after 6 months compared to baseline without any statistical significance.Conclusion: No negative effects on the periodontal tissues were noted around the canines during the application of orthodontic tooth extrusion. A very slight increase of the keratinized gingiva width was detected at the examined teeth after 6 months comparing to baseline without any statistical significance.

INTRODUCTION

Movement of a tooth by extrusion involves applying traction forces in all regions of the periodontal ligament to stimulate marginal apposition of crestal bone. Because the gingival tissue is attached to the root by connective tissue, the gingiva follows the vertical movement of the root during the extrusion process. Similarly, the alveolus is attached to the root by the periodontal ligament and is in turn pulled along by the movement of the root.

During the orthodontic tooth movement, it is very important for the periodontal tissues to be in a balanced situation along with the tooth at the cervical areas (1).

The attached gingiva is the part of gingival tissues that is continuous with the marginal gingiva. It is firm, resilient, and tightly bound to the underlying periosteum of alveolar bone. The width of the attached gingiva is defined as the distance between the mucogingival junction and the projection on the external surface of the bottom of the gingival sulcus or the periodontal pocket. It should not be confused with the width of the keratinized gingiva because the latter also includes the marginal gingiva.

It has been assumed that a minimal width of attached gingiva is required for optimal gingival health to be maintained. However, several studies have challenged the view that a wide keratinized gingiva is more protective against the accumulation of plaque than a thin or a nonexistent zone. Teeth with subgingival restorations and narrow zones of keratinized gingiva have higher gingival inflammation scores than teeth with similar restorations and wide zones of attached gingiva (2).

Moreover, it seems to be that a sufficient amount of keratinized gingiva is more valuable for the gingival health and to allow the orthodontic appliances, whether removable or fixed, to achieve the corrective treatment without any harmful effect on the periodontal hard and/or soft tissues (3).

The orthodontic extrusion movements seem to be the least harmful to the periodontal tissues when applied correctly in the orthodontic treatment.

Ingeber et al. (4) studied the effect of the extrusive

orthodontic movement on one or two-wall infrabony defects, and they found that the extrusion of one tooth or more had a significant effect of reducing the periodontal pocket depths.

In other studies, it had been demonstrated that teeth extrusion, when gingival inflammation is already existed, reduced the probing depth values, the bleeding on probing and induced the creation of new bone on the alveolar bone crest.

Upwarding and the extrusion of the molars without any scaling or root planning had been shown to reduce the amount of the bacterial pathogens around those molars and to enhance the healing of the osseous defect (5). However, most of the studies considering the periodontal tissues' changes during an orthodontic extrusion discussed only the histological changes in order to find out the aspects of the alveolar bone remodeling, and rarely mentioned the clinical changes of the gingival tissues.

Kajiyama et al. (6) examined the effect of the orthodontic extrusion movement on the gingival tissue in the central incisors of five Macaca Fuscata monkeys. After those incisors had been extruded, a slight movement of the gingival margin in the same direction of the extruded teeth could be noted and an increase of the keratinized gingiva width (KGW) was also recorded.

However, it is still difficult to find out the real reason of the increase of the keratinized gingiva during the orthodontic extrusion whether it is due to the proliferation of the gingival tissue or to its elastic nature, that is because the proliferation of the fibroblasts as well as the connective tissue changes in volume and the intra-fibers spaces were all immeasurable in most of the studies.

The aim of the current study was to examine the effect of the orthodontic extrusion movements on the periodontal parameters during a 6-month period of clinical observation and to find out whether orthodontic tooth extrusion makes the gingival margin move in a coronally direction.

MATERIAL AND METHODS

STUDY POPULATION

Seven orthodontic patients (five females and two males, mean age of 19.5±2.5 years) from the Department of Orthodontics, Faculty of Dental Medicine, Damascus University, Damascus, were selected to participate in this study.

To be eligible for the study, those patients had to meet the following criteria: (1) good general health; (2) lack of antibiotic therapy during the previous 6 months; (3) absence of anti-inflammatory drug administration in the month preceding the study; (4) periodontally healthy with generalized probing depths ≤ 3 mm and no radiographic evidence of periodontal bone loss; and (5) requirement of upper canines extrusion in order to correct their abnormal positions into a more normal level within the dental arch.

An oral approval from the patients to be subjected to the study, or from the parents of patients less than 18 years of age, was obtained prior to the commencement of the study.

One week before the baseline examination, all patients underwent a session of supra – and subgingival ultrasonic scaling.

EXPERIMENTAL DESIGN

It was recommended to include in this study only patients who had simple to moderate canine position-abnormalities, with the ability to finish the orthodontic correction in 6 months maximally.

Through a complete orthodontic treatment plan, the upper first premolars in both right and left sides were extracted for all patients.

Ten days after the extraction of the first premolars, the upper canines (right and left) were subjected to coronally orthodontic extrusion movements.

The technique used in the current study involved placing orthodontic brackets on the buccal aspect of the teeth adjacent to the tooth that is to undergo extrusion (in this case; canines) in a passive position that will not cause any orthodontic movement of the anchor teeth. The brackets on the canines are positioned more apically than the brackets on the adjacent teeth; the difference in distance represents the desired extrusion. A 0.016-in. nickel–titanium arch wire was attached to the brackets. When greater movement was desired, a second, more rigid wire (0.016 in. × 0.022 in.), attached only to the brackets of the adjacent teeth, was used to stabilize everything. Following extrusion, a more rigid 0.018-in. stainless steel arch wire was inserted and set by means of a metal ligature for a minimum retention period of 12 weeks.

All important modifications were made according to every case separately.

CLINICAL MONITORING AND KERATINIZED GINGIVA WIDTH (KGW) ASSESSMENT

The status of the periodontal tissues around the canines to be extruded was determined by clinical periodontal assessments, including Plaque Index (PI) (7), Papillary Bleeding Index (PBI) (8), Probing Depth (PD) and Gingival Index (GI) (9).

The plaque index assesses only the thickness of the plaque at the gingival area of the tooth. It examines the following scoring units of the teeth: distofacial, facial, mesiofacial and lingual surfaces. A mouth mirror and a dental explorer are used after air drying of the teeth to assess plaque, and the PI score for each area is obtained by totaling the four plaque scores per tooth.

The papillary bleeding index assesses the sulcus bleeding on probing at the interdental papilla. This index used a scale of 0 to 4 as follows:

The probing depth is the distance to which an instrument (probe) penetrates into the pocket.

In our study, the periodontal pocket depth was measured with a millimeter-calibrated periodontal probe (Michigan O probe) on the following scoring units of the teeth: distofacial, facial, mesiofacial and lingual surfaces. The probe was inserted with a firm, gentle pressure to the bottom of the pocket. The shank should be aligned with the long axis of the tooth surface to be probed.

The gingival index assesses the severity of gingivitis and its location in four possible areas: the distofacial papilla, the facial margin, the mesiofacial papilla and the entire lingual gingival margin.

Those clinical parameters were assessed as follows: at baseline (prior to orthodontic appliance placement), after 1 month, after 3 months, and after 6 months.

The width of keratinized gingiva was measured at every canine according to the method explained by Sadowsky and Begole (1981) (10) where every single measurement was made from the free gingival edge to the muco-gingival conjunction on the buccal surface of the canine. The resulted measurements were recorded to the nearest 1 mm.

STATISTICS

The values were calculated as the Mean ± Standard Deviation (SD) and Analysis Of Variance (ANOVA), a calculation procedure to allocate the amount of variation in a process and determine if it is significant or is caused by random noise, was used to evaluate the statistical significance of the differences of the clinical measurements among the experimental categories in each group/column.

A probability of $P \leq 0.05$ was accepted for rejection of the null hypothesis and to state that with a 95% level of confidence that the two parameters are not the same.

All the statistical analyses were done by means of a computer software program (SPSS -2006).

RESULTS

The clinical periodontal indices of the subjects recorded at baseline were expressed as Mean ± SD as follows:

0.10±0.21, 2.06±0.50, 0.31±0.23 and 0.39±0.34 for the PI, PD, GI and PBI respectively. After 6 months the indices were measured as 0.67±0.63, 2.27±0.54, 0.81±0.26 and 0.57±0.43 for the PI, PD, GI and PBI respectively. The values of PI increased significantly when comparing the values at baseline with those after 6 months ($P<0.05$), where the PD and PBI values did not show any important differences. The gingival index also increased significantly from (0.31) at baseline to (0.52), (0.75) and (0.81) after 1 month, 3 months and 6 months respectively ($P<0.05$).

The width of the keratinized gingiva registrations (measured in millimeters) were as follows: 5.21±1.47, 5.42±1.22, 5.35±1.21 and 5.35±1.21 mm at Baseline, 1 month, 3 months and 6 months respectively. No statistically significant results were found between the measurements during the whole period of observation. Table (1) illustrates the records of the clinical indices and KGW records during different time points of the study.

Figure 1

Table (1): The periodontal indices (PI, PD, GI and PBI) and the keratinized gingiva width (KGW) records during different time points of the study

	Baseline	1 Month	3 Months	6 Months	ANOVA Test
PI	0.10±0.21	0.37±0.37	0.37±0.34	0.67±0.63*	(P<0.05)*
PD	2.06±0.50	2.25±0.51	2.05±0.37	2.27±0.54	NS
GI	0.31±0.23	0.52±0.31†	0.75±0.39‡	0.81±0.26*	(P<0.05)†‡*
PBI	0.39±0.34	0.53±0.41	0.89±0.83	0.57±0.43	NS
KGW	5.21±1.47	5.42±1.22	5.35±1.21	5.35±1.21	NS

Results of pairwise comparisons over the time points within each group:

*** (Baseline) versus (6 months)**
† (Baseline) versus (1 month)
‡ (Baseline) versus (3 months)
NS: Not significant

DISCUSSION

This study was designed to show whether extrusive orthodontic movements have negative effects on the periodontal tissues, and to detect the relationship between tooth extrusion and the width of the keratinized gingiva. Fourteen upper canines (7 patients) were subjected to this study.

The values of the plaque index PI increased significantly after 6 months, and this logical increase reflects the high ability of fixed orthodontic appliances to retain the dental plaque within their components (e.g. brackets, wires, etc...). This concept was clearly explained by Travess et al. (11) and Zhao et al. (12) in their related studies.

However, according to the repeated oral hygiene instructions, which were given to the patients during the whole period of the study, the values of the plaque index were kept within normal limits since a maximum value of 0.67 has been recorded after 6 months.

Looking deeply into the probing depth PD values, it could be seen that the mean of the measured values was 2.06 mm at the baseline which was a normal value and expressed the healthy situation of the chosen samples (No gingival pockets were existed at Baseline). No statistical significance was noted related to the different values of PD during the whole period of the study, despite a slight increase after 1 month and after 6 months. This maximum value of 2.27mm of PD after 6 months is considered to be an accepted healthy pocket depth and could be explained by the plaque accumulation and the slight gingivitis occurred. Those results agree definitely with the study results of Kajiyama et al. (6) who noted the absence of any diseased gingival pockets or gingivitis on the buccal surfaces of extruded upper incisors.

All the values of the gingival index were kept within normal limits without any signs of destructive progress in the periodontal tissues around the examined teeth. However, the gradual increase of the gingival index from 0.31 (Baseline) to 0.81 (after 6 months) is considered to be normal and logic according to the gradual increase of the plaque index.

Orthodontic extrusion forces coronal migration of the root and increases the bone ridge as well as the quantity of attached gingiva, in particular when weak to moderate forces are applied (13-14).

The amount of attached gingiva is increased through eversion of the sulcular epithelium, appearing first as immature non keratinized tissue (known as “red patch”) and then as keratinized tissue. The process of keratinization requires 28 to 42 days (15). After coronal movement of the periodontal attachment has occurred, minor surgical correction may be necessary. To avoid or minimize this correction, some authors recommend weekly fibrotomy (incision of the supracrestal gingival fibers) (16-17).

In our study, no significant increase of the keratinized gingiva width of the examined canines could be noted after 6 months of continuous extrusion forces. A slight increase from 5.21mm (at Baseline) to 5.35mm (after 6 months) could be noted, but without any statistical significance. There was also an increase of KGW from 5.21mm (at Baseline) to 5.42mm (after 1 month), and that might be related to the gingival inflammation occurred during the first month. These results – although not statistically significant – agree with the results of Kajiyama et al. (6) and with those of Bathenhorst et al. (18).

In almost every orthodontic treatment plan, estimating the orthodontic forces to be applied seems to be of great importance.

Forces of 15 g for the fine root of a lower incisor and 60 g for a molar are sufficient for slow extrusion. Some authors recommend that the maximum force for a slow movement should not exceed 30 g (15, 19) whereas rapid extrusions are

accomplished with forces higher than 50 g (20).

After a latency period of a few days to a few weeks, including a period of hyalinization, slow extrusion occurs at a rate of approximately 1 mm or less per week (15).

The forces used in our study varied depending on the physiologic response of the patient and other factors such as root surface morphology. Moreover, the extent of the forces exerted could only be approximated, since it was difficult to quantify the forces applied.

The orthodontic forces must be adjusted on the basis of the clinically verified speed of extrusion. It is imperative that constant force be maintained between the extrusion and hyalinization phases; otherwise, the desired orthodontic movement will not take place. Periodontal ligament tension is needed for bone remodeling and movement of the periodontal attachment (21), and the force must be applied along the tooth axis to prevent any undesirable tilting. According to the methods used in the current study, it could be stated that we used slow orthodontic extrusion forces of 30g.

In 1999, Sanders (22) conducted a review to explain the relationship between orthodontic tooth movements and several types of periodontal problems, and it has been shown that correct orthodontic treatment of patients who had excellent oral hygiene and did not suffer from any periodontal diseases was a non-harmful treatment, and it was also proved that the absence of good oral hygiene in corporation with periodontal disorders would make any orthodontic movement a real risk factor for the periodontal tissues. However, the importance of the oral hygiene during the orthodontic treatments was discussed in details in many other studies (23-27).

In the current study, and before any fixed orthodontic appliance had been applied to the patients, written and verbal oral hygiene instructions were given to them with emphasize on keeping the mouth “clean” through the 6 months of observation. All oral hygiene instructions were repeated for the patients at every visit. This could explain why the whole indices were kept within normal limits, and no signs of a serious destruction of the periodontal tissues according to the extrusion forces were noted.

Thus, within the limitations of the current study and the restricted sample volume, it could be stated that the extrusion of teeth during an orthodontic treatment does not have any specific negative effects on the periodontal tissues when a good level of oral hygiene is maintained by the patient.

In conclusion, this study initially demonstrated a low increase in PI and GI indices during the whole period of clinical observation of canines underwent slow extrusive forces. The PD and PBI indices did not show any important difference. A very slight increase of the KGW was detected at the examined teeth after 6 months comparing to baseline without any statistical significance. Whether the orthodontic forces used in this study were “only extrusive” without any other possible movements’ components was not exactly clear and may need further studies since often on vestibular ectopic canines, there is a buccal vector on the displacement.

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References

1. Wennstrom JL. Mucogingival considerations in orthodontic treatment. Semin Orthod. 1996 Mar;2(1):46-54.
2. Carranza F, Takei. H. Mucogingival Surgery. In: MG CFaN, editor. Clinical Periodontology. Philadelphia, Pennsylvania: W.B. Saunders Company; 1996. p. 651-70.
3. Wennstrom J, Lindhe J, Nyman S. Role of keratinized gingiva for gingival health. Clinical and histologic study of normal and regenerated gingival tissue in dogs. J Clin Periodontol. 1981 Aug;8(4):311-28.
4. Ingber JS. Forced eruption: alteration of soft tissue cosmetic deformities. Int J Periodontics Restorative Dent. 1989;9(6):416-25.
5. Melsen B. Tissue reaction following application of extrusive and intrusive forces to teeth in adult monkeys. Am J Orthod. 1986 Jun;89(6):469-75.
6. Kajiyama K, Murakami T, Yokota S. Gingival reactions after experimentally induced extrusion of the upper incisors in monkeys. Am J Orthod Dentofacial Orthop. 1993 Jul;104(1):36-47.
7. Silness J, Loee H. Periodontal Disease in Pregnancy. Ii. Correlation between Oral Hygiene and Periodontal Condtion. Acta Odontol Scand. 1964 Feb;22:121-35.
8. Muhlemann HR. Psychological and chemical mediators of gingival health. J Prev Dent. 1977 Jul-Aug;4(4):6-17.
9. Loee H, Silness J. Periodontal Disease in Pregnancy. I. Prevalence and Severity. Acta Odontol Scand. 1963 Dec;21:533-51.
10. Sadowsky C, BeGole EA. Long-term effects of orthodontic treatment on periodontal health. Am J Orthod. 1981 Aug;80(2):156-72.
11. Travess H, Roberts-Harry D, Sandy J. Orthodontics. Part 6: Risks in orthodontic treatment. Br Dent J. 2004 Jan 24;196(2):71-7.
12. Zhao H, Xie Y, Meng H. [Effect of fixed appliance on periodontal status of patients with malocclusion]. Zhonghua Kou Qiang Yi Xue Za Zhi. 2000 Jul;35(4):286-8.
13. Ainamo J, Talari A. The increase with age of the width of attached gingiva. J Periodontal Res. 1976 Jul;11(4):182-8.
14. Rosenberg ES, Cho SC, Garber DA. Crown lengthening revisited. Compend Contin Educ Dent. 1999 Jun;20(6):527-32, 34, 36-8 passim; quiz 42.

15. Minsk L. Orthodontic tooth extrusion as an adjunct to periodontal therapy. Compend Contin Educ Dent. 2000 Sep;21(9):768-70, 72, 74 passim.
16. Lythgoe JR, Torabinejad M, Simon JH. Extrusion techniques for the general dentist. Gen Dent. 1980 Jan-Feb;28(1):42-3, 6-9.
17. Palomo F, Kopczyk RA. Rationale and methods for crown lengthening. J Am Dent Assoc. 1978 Feb;96(2):257-60.
18. Batenhorst KF, Bowers GM, Williams JE, Jr. Tissue changes resulting from facial tipping and extrusion of incisors in monkeys. J Periodontol. 1974 Sep;45(9):660-8.
19. Reitan K. Clinical and histologic observations on tooth movement during and after orthodontic treatment. Am J Orthod. 1967 Oct;53(10):721-45.
20. Bondemark L, Kurol J, Hallonsten AL, Andreasen JO. Attractive magnets for orthodontic extrusion of crown-root fractured teeth. Am J Orthod Dentofacial Orthop. 1997 Aug;112(2):187-93.
21. Alves LD, Donnelly JC, Lugo A, Carter DR. Reeruption and extrusion of a traumatically intruded immature permanent incisor: case report. J Endod. 1997 Apr;23(4):246-8.
22. Sanders NL. Evidence-based care in orthodontics and periodontics: a review of the literature. J Am Dent Assoc. 1999 Apr;130(4):521-7.
23. Boyd RL, Chun YS. Eighteen-month evaluation of the effects of a 0.4% stannous fluoride gel on gingivitis in orthodontic patients. Am J Orthod Dentofacial Orthop. 1994 Jan;105(1):35-41.
24. Brightman LJ, Terezhalmy GT, Greenwell H, Jacobs M, Enlow DH. The effects of a 0.12% chlorhexidine gluconate mouthrinse on orthodontic patients aged 11 through 17 with established gingivitis. Am J Orthod Dentofacial Orthop. 1991 Oct;100(4):324-9.
25. Denes J, Gabris K. Results of a 3-year oral hygiene programme, including amine fluoride products, in patients treated with fixed orthodontic appliances. Eur J Orthod. 1991 Apr;13(2):129-33.
26. Jackson CL. Comparison between electric toothbrushing and manual toothbrushing, with and without oral irrigation, for oral hygiene of orthodontic patients. Am J Orthod Dentofacial Orthop. 1991 Jan;99(1):15-20.
27. Pontier JP, Pine C, Jackson DL, DiDonato AK, Close J, Moore PA. Efficacy of a prebrushing rinse for orthodontic patients. Clin Prev Dent. 1990 Aug-Sep;12(3):12-7.

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