

Changes in lower incisor inclination and the occurrence of gingival recession

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Abstract

Objectives: The aim of this study was to investigate whether altering the labial-lingual position of lower incisors in adolescents might predispose to the development of gingival recession. **Methods:** Records from 189 Caucasian adolescents (107 female and 81 male) pre and post orthodontic treatment were selected. Patients yielded mean \pm SD values of initial records age 11.2 ± 1.9 years and final records age 14.7 ± 1.8 years. The presence of gingival recession was evaluated in models and photographs. The inclination of lower incisors to the mandibular plane angle (IMPA) was measured on lateral cephalograms, pre and post treatment. **Results:** No significant association was observed between changes in tooth inclination and the presence of gingival recessions, based on chi-square analysis ($p = 0.277$). Data demonstrated that in 107 patients (56.6%) incisors were proclined, in 64 patients (33.9%) incisors were retro-inclined and 18 patients (9.5%) did not show any changes in tooth inclination. In the cases where new gingival recessions occurred, 64.9% had been moved buccally, 26.3% had been moved lingually and 8.8% did not change inclination. In the group of patients that displayed coronal migration of the gingival margin, 60% were moved lingually, 30% were moved buccally and 10% did not change inclination. **Conclusions:** Even though the percentage of cases where teeth were proclined showed a larger number of new gingival recessions, it was not statistically significant.

Keywords: Lower incisors. Inclination. Gingival recession. Orthodontic tooth movement.

INTRODUCTION

Determining the ideal position of lower incisors has hitherto posed a challenge in Orthodontics both in terms of stability^{13,15} and periodontal conditions^{4,18}. When teeth move across alveolar bone, hard and soft tissues undergo remodeling, which involves a variety of cells and tissue reactions in tandem with periodontal fibers¹⁹.

Some studies have reported that tooth movements outside the alveolar bone resulting from excessive inclination predispose to a loss of gingival attachment buccally, which leads to gingival recession^{3,11,27,28}. Others report that there is no evidence associating tooth movement with gingival recession development^{1,2,14,21}.

Experimental studies with monkeys²² and

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dogs¹² have demonstrated that fenestrations can be produced in alveolar bone when lower incisors are moved buccally³. Nevertheless, the bone remodeling which occurs following this movement does not seem to entail any attachment tissue loss since this tooth movement occurs inside the dental arch and the supracristal supporting tissue is kept inflammation-free¹².

Engelking and Zachrisson⁹, repositioning monkey incisors to their original location after these teeth had been orthodontically protruded showed that there occurred buccal bone reapposition in the coronal orientation. This observation demonstrated that there could be an improvement in bone fenestration and gingival recession^{9,12}.

The position of the tooth upon eruption has also been regarded as a local factor which may lead to gingival recession. However, the presence of trauma caused by brushing and plaque-related gingival lesions should be considered a key causative factor in orthodontic patient recession²⁵.

At the time orthodontic planning is made patients very often present with a retrusive mandible and teeth which are already excessively inclined. In order to enhance aesthetics and avoid surgical procedures teeth are kept at or moved to an even more proclined position. Additionally, most studies investigating the impact of changes in tooth inclination and changes in the gingival margin were performed on non-specific age brackets⁶ or on adult patients^{10,11,21}.

The purpose of this study was to investigate whether altering the labial-lingual position of lower incisors in adolescents might predispose to the development of gingival recession.

MATERIALS AND METHODS

Sample

Intraoral photographs, preliminary casts and cephalograms of 189 Caucasian adolescents (107 female and 81 male) were selected, prior to and following orthodontic treatment. These cases were selected from records of 209 patients

who had finished orthodontic treatment in private clinics using fixed appliances. Patients were treated with Standard Edgewise and Straight wire appliances. The mean starting age was 11.2 ± 1.9 years standard deviation and a final mean age of 14.7 ± 1.8 years. The active treatment mean was 1.99 ± 0.89 years.

Inclusion criteria

To take part in this study, patients had to present with either Angle's Class I or Class II, sectional or vertical problems; the presence of diastema or maximum 4 mm lower incisor crowding; treated with no extractions; with permanent lower incisors and cuspids erupted; apparent periodontal health; final records issued no earlier than 28 days following appliance removal; and cephalograms should be clear enough as to allow scanning.

All patients were given oral hygiene instructions immediately following orthodontic appliance placement and during treatment.

Exclusion criteria

Excluded patients comprised those whose incisors were missing or not yet erupted, with an Angle Class III malocclusion, who reported pre-existing systemic diseases or who were on medication due to gingival alterations. Follow-up of periodontal conditions was performed based on individual needs. About 20% of the records were disregarded on account of inaccurate casts or photographs, which compromised assessment.

Main variable

The independent variable was gingival recession, which was assessed by means of visually evaluating the preliminary casts and with the aid of pre and post treatment intraoral photographs. Teeth were considered to present with recession when exposure of the amelocemental junction was detected. The amount of recession was quantified using a digital gauge (Mitutoyo Digimatic®, Mitutoyo Ltd, UK) and values were rounded to

the nearest tenth of a millimeter. (Fig. 1). Cases were assessed prior to and following orthodontic treatment, whereas teeth were classified as in: (a) unaltered gingival margin position; (b) coronal migration; or (c) apical migration of the gingival margin.

Prior to starting the study, the position of the gingival margins was gauged by evaluating the photographs and casts within a time interval of one week, without any knowledge of the previous evaluation. The Kappa test was used to evaluate intra-observer concordance. Perfect reproducibility was achieved once ($Kappa = 1$) after extensive practice.

After the data had been collected, a multiplication factor was set to calculate the actual amount of gingival recession since the measurements were performed on photographs, which did not reflect the actual size of the variable being measured. To correct photo magnification, the size of the upper right incisor crown was compared – on the photograph – with the dimensions of the same tooth on the cast. The following equation was used: Actual recession equals the recession measured on the photograph times the size of the cast crown, divided by the crown length – measured on the photograph – as suggested by Djeu, Hayes and Zawaideh⁷.

$$\text{Actual recession} = \frac{\text{recession measured on the photograph} \times \text{size of cast crown}}{\text{crown length on the photograph}}$$

Independent variable

The lateral cephalograms were scanned and cephalometric points marked and scanned with Radioceph software (Radiomemory, Belo Horizonte, Brazil) run by a well-trained observer who was not informed about the gingival recession measurements. Lower incisor inclination was assessed by altering the IMPA angle (Fig. 2). Initial and final measurements were assessed and divided into 3 groups: Patients presenting with proclined teeth, patients with retroinclined teeth

and patients with no buccolingual changes in the lower incisors.

Evaluation of method error

In order to evaluate the method error in locating the points and the radiographic overlay, 10 cephalograms were randomly selected after being traced and superimposed twice. The following equation was used to calculate the methodological error $S_x = \Sigma d^2 / 2n$, where “d” is the difference between the duplicated measurements and “n” are the duplicated records⁵. The radiographic variable



FIGURE 1 - Recession measurement.

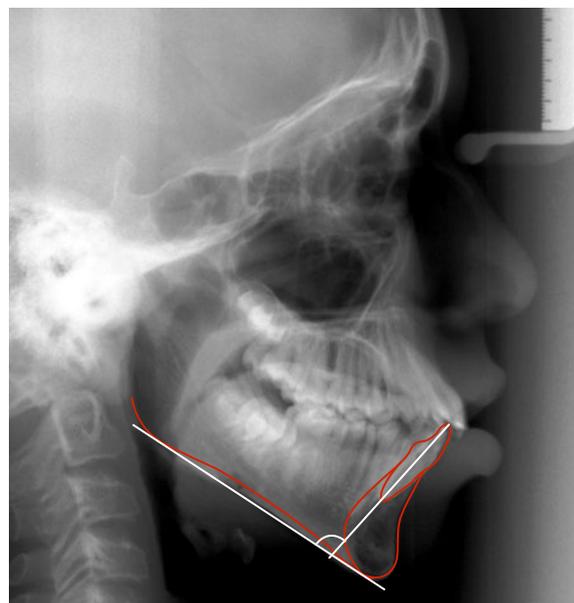


FIGURE 2 - Lower incisor inclination measurement.

error did not exceed 0.58° . The cephalometric measurements were rounded to the nearest 0.5° .

Statistical analysis

The relative and absolute frequencies dependent and independent variables were obtained. Chi-square analysis was used to investigate the association between gingival recession and tooth inclination. Tooth inclination variation (Δ inclination) was calculated to assess the differences between the variables, and the non-parametric Kruskal-Wallis¹⁶ test was applied to the patients, who came to the analysis unit. An alpha level of 0.05 was defined.

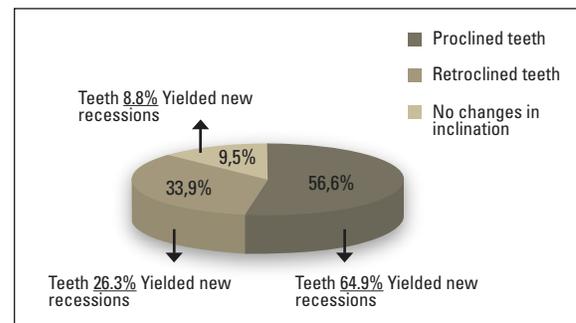
RESULTS

The cases were divided according to the changes which took place in the lower incisor gingival margin after treatment. The collected data showed that the incisors of 107 patients (56.6%) were moved towards buccal, the incisors of 64 patients (33.9%) were moved towards lingual, whereas 18 patients (9.5%) did not display any changes in tooth inclination. The cases were further subdivided into 3 groups: (a) occurrence of gingival recession, (b) coronal migration of gingival margin and (c) unchanged position of gingival margin. In those cases where gingival recession occurred, 64.9% were moved towards buccal, 26.3% were moved towards lingual and 8.8% did not show any inclination changes (Graph 1).

In the group of patients who experienced coronal migration of gingival margin, 60% were moved towards lingual, 30% were moved towards buccal and 10% did not show any inclination changes. In the cases where the gingival margin was altered, 54.9% were moved towards buccal, 45.2% were moved towards lingual and 9.8% had no inclination changes at all.

A Chi-square analysis failed to demonstrate a significant association ($p = 0.277$) between the changes in tooth inclination and the presence of new gingival recessions (Table 1).

In patients where recession occurred, the mean inclination was $+2^\circ$, whereas the first and third quartiles were -1.54 and $+5.68^\circ$, respectively. When the gingival margin migrated coronally, the mean value of lingual-oriented movement was -1.13° . Individuals whose tooth inclinations were changed yielded a mean value of $+0.89^\circ$,



GRAPH 1 - Changes in tooth inclination and new recessions.

TABLE 1 - Association between changes in the gingival margin following orthodontic treatment and orthodontic inclination movement.

Inclination	Gingival margin position classification							
	Coronal gingival migration		Unchanged gingival margin		Gingival recession		total	
	n	%	n	%	n	%	n	%
retroinclined	6	60,0	43	35,2	15	26,3	64	33,99
unchanged	1	10,0	12	9,8	5	8,8	18	9,5
proclined	3	30,0	67	54,9	37	64,9	107	56,6
total	10	100	122	100	57	100	189	100

$X^2 = 5,10$; $p = 0,2777$.

TABLE 2 - Association between the occurrence of gingival recession and initial and final differences in tooth inclination.

classification	Δ inclination			
	1 st Quartile	2 nd Quartile	3 rd Quartile	Mean
Coronal gingival migration	-2,34	-1,13	3,60	77,7
Unchanged gingival margin	-2,08	0,89	4,88	93,70
Gingival recession	-1,54	2,00	5,68	100,82

Kruskal-Wallis: $p = 0,424$.

whereas the first and third quartiles were -2.08° and $+4.88^\circ$, respectively. The lowest mean value (77.70) was observed when the gingival migration moved coronally, whereas the highest mean value (100.82) was observed in individuals who presented with new recessions.

When the group of patients was divided by gender, no significant difference was observed.

DISCUSSION

The goal of the present study was to investigate the possible association between changes in buccolingual inclination of lower anterior teeth during orthodontic treatment and the development of gingival recessions. Although some authors^{12,21} assert that any tooth that is moved outside the dentoalveolar envelope is predisposed to bone fenestration followed by gingival recession, such phenomenon was not found to be true in this study.

In the group of patients whose teeth were moved towards buccal (56.6%), as well as those whose teeth were moved towards lingual (33.9%), no association with the development of gingival recession was noted.

Many methodological considerations could be made to better assess the present study. Firstly, this is a retrospective longitudinal study where only radiographs, photographs and models were analyzed. The limitations of this approach should be taken into account. Nevertheless, by calibrating and training observers, the authors tried to

avoid methodological errors. The fact that the two observers were blinded when analyzing the other variables ensured an unbiased evaluation.

Although adults often seek orthodontic treatment, this population is not the prevailing patient base at orthodontic clinics. The population of the present study fell within an age bracket analogous to the majority of patients who seek orthodontic treatment and who still have growth potential^{23,24}. The few studies which evaluated the effects of lower incisor inclination and the gingival margin position exclusively were either conducted on non-specific age groups⁶ or on adults^{3,7,27}. One such study, performed by Ruf, Hansen and Pancherz²¹, which addressed the same issues as the present study, analyzed orthodontic treatment using a specific orthodontic appliance for a shorter period of time and with a smaller sample size.

Many studies have demonstrated that behavioral factors, particularly the pattern of oral hygiene in children and adolescents during orthodontic treatment, are, more often than not, inadequate^{8,20}. Considering this observation, any other controllable risk indicator should be known.

The methodology employed in this investigation to assess gingival recession has been reported in a number of other studies^{2,21,27}. It is unquestionable that a clinical inspection of the gingival margin position directly in the subjects' mouths would have been desirable. However, in view of the sample size and observation time – prior to and following orthodontic treatment completion – the likelihood of errors was minimized. In the present study, gingival recessions were assessed by visually inspecting intraoral photographs and preliminary casts. Other studies have evaluated the length of the clinical crown^{1,2,7}. This, however, may not constitute an accurate indicator of gingival recession. The simple mathematical analysis of crown length is error-prone since teeth can extrude without the occurrence of gingival margin apical migration and therefore result in crown lengthening. This may lead professionals to mistakenly classify such

patients as gingival recession cases.

The changes resulting from tooth inclination were assessed with the aid of the National Institute for Pure and Applied Mathematics (IMPA) standards. The mean value was reached based on a lateral cephalogram. This mean value does not reflect the position of each individual lower incisor with accuracy but rather the position of the most prominent tooth in that region. In fact, the use of cephalograms is a very common method described in the literature as a tool to determine lower incisor inclination^{3,7,11,24}.

This is a retrospective-longitudinal study where individuals who met the inclusion criteria were selected irrespective of the directional movement of their lower incisor teeth. In order to evaluate the process through which recessions evolve, it would be necessary to perform intermediate assessments in predetermined periods during the treatment as well as to secure control of hygiene habits. The results achieved with this study, however, can mirror with greater clarity the actual impact of orthodontic treatment on gingival margin position, free from the Hawthorne effect.

A retrospective study, which sought to evaluate the periodontal conditions found after mandibular incisor proclination, was conducted with a sample of Class II patients treated during mixed dentition². In this study, a group of Class II patients who had not presented with proclined teeth was used as control group. In terms of recession, the findings were similar to the present study. No difference was noted between the test and control groups in the number of lower incisors which developed recession from the pre to the post-treatment periods.

Once it had been observed in other studies that bone compensatory formation can occur when teeth are moved to their original positions^{12,19}, it might be assumed that the gingival margin would follow the bone closely and thus no recession would take place. The present study shows that although no strong correlations were

detected, a tendency exists towards the coronal migration of the gingival margin of teeth which are moved lingually, compared with teeth which are moved buccally.

On the other hand, in a study using an animal model²⁶ where the upper incisors had been moved buccally, a significant gingival margin apical migration was observed after tooth movement. Such results may have been negatively impacted by the fact that the teeth involved presented with signs of gingival inflammation.

Another study¹, which assessed gingival recession in adults following excessive incisor proclination, showed that 10% of the patients developed new recessions and 5% displayed gingival margin coronal migration. Similarly to the present study, most subjects (85%) did not show any gingival margin alterations.

Previous studies yielded contradictory results^{3,6}. Geiger and Wasserman¹⁰ investigated the relationship between occlusion and periodontal disease and postulated that lower incisor labial gingival recession would be connected to linguoversion (with a lower than 85° IMPA score). Yared, Zenobio and Pacheco²⁷, however, noted that lower central incisors with a 95° IMPA score and gingival margin thickness smaller than 0.5 mm yielded severe recessions. Based on the results of this study, the increased risk reported by some authors^{3,11,27,28} of lower incisor proclination is not clearly supported by the evidence. In fact, 15 individuals who experienced gingival recession in the present study had their incisors retroclined and 5 of them did not show any changes in tooth inclination. This could lead one to question the recommendation made by some authors^{10,18} to perform a pretreatment gingival graft as a preventive measure in those cases where teeth need to undergo extensive motion. It should be reported that none of the patients in this study were subjected to gingival graft either prior to or following orthodontic treatment.

Nevertheless, regardless of the type of move-

ment executed, there was an increase in the number of patients (57) who presented with new post-treatment gingival recessions. Other independent variables, such as buccal hygiene pattern, amount and thickness of gingival tissue and features of the alveolar process should be further investigated.

CONCLUSION

The results of the present study indicate no association whatsoever between lower incisor inclination and gingival recession.

Submitted: fevereiro de 2007
Reviewed and accepted: março de 2008

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