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Original article

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Long-term evaluation of lower incisors gingival recessions after orthodontic treatment

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Summary

Aim: The development of gingival recessions has been associated with orthodontic treatment; however, a clear etiology is still unknown. The aim of the present study was to further clarify potential association between the development of labial and lingual recessions and inclination of the lower incisors during orthodontic treatment, vertical facial morphology, width of the alveolar bone process, height and width of their symphysis after orthodontic treatment and at long-term retention.
Methods: On dental casts and good quality lateral cephalograms of 126 orthodontically treated patients, relevant measurements were performed and gingival recessions were assessed and recorded before, immediately after treatment and at long-term retention.
Results: Taking into account the whole sample at three different occasions, on the buccal side, the lateral incisors have significantly less recessions than the central incisor. On the lingual side, tooth 32 presented with lower risk of recession compared to all other three incisors. No association was found between the width of the alveolar bone process at the apex (Wapex), at the level of the crest (Wcrest) and at mid of the root (Wmid), the width (D), the vertical skeletal pattern (AnsPns-Go'Me) and the onset of buccal or lingual recessions. Development of new recessions was clearly associated with males and with increasing age. The symphysis height (Me-Wcrest) was statistically related with the onset of lingual recessions on 32 and 42. The ratio between the symphysis height and the width at the crest level demonstrated a statistically significant association with the presence of buccal and lingual recessions. Excessive proclination (≥10°) of the lower incisors demonstrated an association with the onset of recessions in 25 per cent of the cases.
Conclusion: Based on the sample of this study, there is some evidence that increased symphysis height (Me-Wcrest), and ratio between the symphysis height and the width at the crest level as well as big change of lower incisor inclination during treatment are associated with the development of recessions.

Introduction

Gingival recession is defined as the displacement of the marginal tissue apical to the cemento-enamel junction (1). Gingival recessions have been associated with thermal sensitivity of teeth, increased risk of root caries (2) and constitute one of the main aesthetic complaints of persons seeking reconstructive periodontal therapy (3).

Gingival recessions are age-dependent and it has been reported that at 20 years, 63 per cent of Caucasian males present at least one recession. This percentage continues to increase and at 50 years, over 90 per cent of the patients have at least one recession (2). Habits such as traumatic tooth brushing (2, 4), piercings, parafunctional activity and occlusal injury (5) have frequently been linked with the development of gingival recessions in non-orthodontic patients. It has also been postulated that anatomic characteristics such as pre-existing lack of alveolar cortical bone due to an ectopic tooth eruption outside the dental arch and bony envelope (6, 7) and a small width of keratinized gingiva and thin gingival biotype (8) are additional etiologic factors.

The development of gingival recessions has been considered a common sequel of orthodontic treatment (9–11). However, the specific aetiology is still unknown. Suboptimal oral hygiene maintenance during treatment (12) and chronic gingivitis in combination with an orthodontic movement may result in gingival recessions. Furthermore, buccal gingival recessions have been associated with a thin symphysis, excessive proclination of mandibular incisors (more than 10 degrees relative to the mandibular line) with displacement of the cervical region of the roots outside the alveolar cortical bone (13).

There is no agreement in the literature regarding the association between incisor proclination or retroclination and the development of gingival recessions (8, 14–20).

The vast majority of the studies dealing with the development of recessions after orthodontic treatment focussed on the labial side. Only one study considered the development of lingual recessions after orthodontic treatment and long-term retention (21).

Artun and Grobéty (15) reported that in orthodontically treated Class II patients without incisor proclination at the end of the treatment, there was an association between recessions at the follow-up period and symphysis width measured at the level of the apex. Patients with recessions had a narrower symphysis width compared to patients without recessions.

Given the controversy in the literature of the effect of the regional anatomy on the development of gingival recessions, the aim of this study was to investigate potential predictors for the development of labial or lingual recessions. Association between gingival recessions and lower incisor inclination changes during orthodontic treatment, individual patient facial morphology, width of alveolar bone and height and width of the symphysis during and after orthodontic treatments were investigated.

Materials and methods

The material of this retrospective study is based on the existing records of patients who have already been treated in the Department of Orthodontics, University of Geneva, Switzerland. Good quality patient records were retrieved from the archives of the Department of Orthodontics and evaluated anonymously, thus no necessity existed for ethical approval. Dental casts and standardized lateral cephalometric radiographs were taken at T0 before treatment, T1 after orthodontic treatment and T2 post retention (mean 7.3 years, range 3.7–14.3 years). The patients had at least one phase of fixed appliance and all patients but two had 3-3 fixed retainers bonded on the lingual surface of the six lower anterior teeth.

Cephalometic lower face morphology

All cephalograms taken at T0, T1 and T2 were traced manually by a single examiner (FP) and measured using a protractor with 0.5 degree and 0.5 mm accuracy. The selected cephalometric landmarks were calibrated between the junior (FP) and the senior author (SK). Cephalometric measurements are shown in Figure 1 and described in Table 1.

Measurements on study casts

All cast recordings were made using a digital calliper with tenths of a millimetre (0.1 mm) scale (Fino GmbH®). The thickness of the alveolar process was measured 4 mm below the buccal and lingual

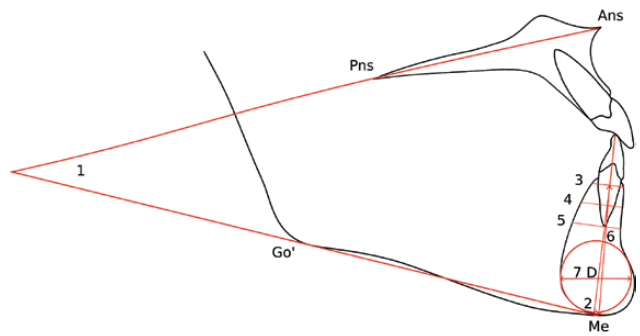

Figure 1. Measurements on lateral cephlograms. Angular measurements: 1, AnsPns-Go'Me; 2,Go'Me-/I. Linear measurements: 3, Wcrest; 4, Wmid; 5, Wapex; 6, Symphysis height (Me-Wcrest); 7, Symphysis width (D) (see Table 1 for definitions).

Table 1. Definitions of angular and linear measurements performed on lateral cephlograms

Angular measurements	
AnsPns-Go'Me (°)	Vertical pattern: intermaxillary angle
Go'Me-/I (°)	Lower incisor inclination
Linear measurements and co-ordinate system	
Wcrest (mm)	Width of the alveolar bone process at the alveolar border
Wmid (mm)	Width of the alveolar bone process at the midpoint
Wapex (mm)	Width of the alveolar bone process at the apical level
Me-Wcrest (mm)	Symphysis height: the distance from a constructed midpoint on the line between the labial and lingual alveolar bone crests and the point menton
D (mm)	Symphysis width: the diameter of the biggest circle fitting the structure

gingival margin of the lower incisors when no recessions were present. When there was a recession, the thickness was measured at 2 mm below the cemento-enamel junction of the incisors. This distance was chosen because the biologic width is normally 2 mm (22). When the gingival margin was on the crown and the cemento-enamel junction was not visible, a score 0 was assigned. When the gingival margin was located on the root, presence of gingival recession was scored 1. All cast recordings were made using a digital calliper with 0.1 mm scale (Fino GmbH®).

Statistical analysis

Two groups of patients were established:

1. a 'growing' group with 101 patients up to 20 years old at T0 (mean 11.5 years old, range 8–19.2 years old) and
2. 'non-growing' group with 26 patients older than 20 years at T0 (mean 32.4 years old, range 20.1–46.5 years old).

Descriptive statistics, means and standard deviations, were calculated for continuous variables. The prevalence of recessions was tabulated by site (buccal, lingual) and per tooth as well as the number of recession sites within patients.

Logistic regression models were fitted separately per tooth and for buccal and lingual recessions. Recessions in time points 2 and 3 were combined. The dependent variable was the presence or absence of recession per tooth and per patient. At the patient level the variable was converted to binary indicating presence or absence of recession. The independent variables were Go'Me/I, AnsPns-Go'Me, Wcrest, Wmid, Wapex, Me-Wcrest, ratio Me-Wcrest/ Wcrest, gender, thickness at 31 and D, all adjusted for the age (less than 20 or more than 20 years old). Patients younger than 8 years of age were excluded. Statistical significance was set at alpha = 0.05 and all analyses were carried out using Stata 14.1 (Stata Corp, College Station, Texas, USA)

Error of the method

Validity of the method to detect recessions on dental casts was tested by comparing the number of clinical diagnosed recessions of the lower incisors of 20 patients with the number of recessions detected on their casts after impressions taken at the same appointment. The kappa of Cohen test (23) was applied to assess the degree of agreement between the two series of scoring.

Measurement reliability was tested through double measurements of 28 randomly selected records, dental casts and lateral cephalograms at one-month intervals. The error of the method was calculated with the Dahlberg's formula (24).

Results

One hundred and thirty-five patients were found in the archive with complete documentation, dental casts and cephalograms at initial, final and post-retention records. Three of those were excluded because of the inadequate quality of the dental casts and five were excluded because they were younger than 8 years. The sample comprised 126 patients [72 females (57 per cent), 54 males (43 per cent)] treated by post-graduate students of the department. The patients had at least one phase of fixed appliance and the shortest treatment time was 10 months.

A high kappa of 0.97 was obtained for the recessions scoring, showing almost perfect agreement between the two repeated assessments. The error of measurements did not exceed 0.4 mm and 2.2 degrees for cephalometric measurements and 0.2 mm for measurements on the dental casts.

The mean age at the beginning of the orthodontic treatment was 11.5 years for the younger group and 32.4 years for the older group. The mean age at the end of treatment was 15.4 years for the young group and 35.2 years for the old group. The mean treatment time was 3.9 years including both one and two stage treatments for the younger group and 2.8 years for the older group. For the younger group, the mean age at T2 was 22.5 years and the mean retention period was 7.1 years. For the older group, the mean age at T2 was 42.3 years and the mean retention period was 7.2 years. All cephalometric measurements are shown in Table 2.

Presence, location and development of recessions

Before treatment, 1 per cent 'growing' and 15.4 per cent 'non-growing' patients presented at least one buccal recession and 1 per cent 'growing' and 11.5 per cent 'non-growing' patients presented at least one lingual recession. After the orthodontic treatment, the percentage of buccal recessions increased to 4 per cent for the 'growing' patients and 30.8 per cent for the 'non-growing' patients. At T2, buccal and lingual recessions increased further to 16.1 and 7.9 per cent, respectively, for the 'growing' patients and 50 and 42 per cent, respectively, for older patients.

Five hundred and six lower incisors from the 126 orthodontically treated individuals were considered. Taking into account the whole sample at three different occasions, on the buccal side, the lateral

Table 2. Descriptive statictics of the changes between the three assessment times for patients less than 20 years old and patients more than 20 years old for: age of the patients, angular and linear measurements on lateral cephalograms (mean and standard deviation)

	T0		T1		T2		T1 – T0		T2 – T1	
	Before treatment		After treatment		Post retention		Treatment changes		Post-treatment changes	
Variable	<20	>20	<20	>20	<20	>20	<20	>20	<20	>20
Age and duration	11.5 [8 to 19.2]	32.4 [20.1 to 46.5]	15.4 [9.4 to 21.9]	35.2 [22.1 to 49.9]	22.5 [14.3 to 29.6]	42.3 [29.8 to 54.8]	3.9 [1.1 to 9]	2.8 [1.2 to 5.7]	7.2 [3.7 to 13.6]	7.1 [4.1 to 14.2]
Intermaxillary angle (AnsPns-Go'Me)	26.2 [13 to 43]	24.7 [7.5 to 48]	24.9 [9 to 45]	24.3 [7.5 to 35]	23.9 [9 to 42]	24.5 [8 to 33]	−1.3 [−8 to 5]	−0.4 [−14 to 6]	−1 [−6 to 5]	0.2 [−2.5 to 3]
Lower incisor inclination (Go'Me-/I)	93.2 [78 to 115]	94.3 [72 to 110]	96.1 [79 to 110]	96.6 [82 to 119]	96.6 [80 to 114.5]	96.3 [79 to 115.5]	2.9 [−10 to 18]	2.3 [−9 to 23]	0.5 [−9 to 11]	−0.46 [−4 to 5]
Alveolar bone process width at the:										
Alveolar border (Wcrest)	6.9 [5.5 to 9]	6.4 [5 to 7]	6.6 [5 to 9]	6.2 [5 to 7]	6.5 [4.5 to 9]	6.3 [5 to 8.5]	−0.3 [−2.5 to 2]	0.3 [−2 to 1]	0.1 [−2 to 2]	0.1 [−1 to 1.5]
Midpoint (Wmid)	7.7 [6 to 11]	6.4 [5.5 to 8.5]	7 [4.5 to 11]	6.1 [5 to 8]	6.9 [5 to 10]	6.4 [5 to 10]	−0.7 [−3 to 2]	−0.3 [−2 to 1]	−0.1 [−3 to 2]	0.3 [−0.5 to 2]
Apical level (Wapex)	9.4 [5.5 to 14]	7.3 [5 to 11.5]	8.5 [4 to 16]	6.9 [4 to 10.5]	8 [4 to 14]	7.3 [4.5 to 12]	−0.9 [−3.5 to 4]	−0.4 [−2.5 to 1.5]	−0.6 [−5 to 2.5]	0.3 [−1.5 to 3]
Symphysis heigth (Me-Wcrest)	31.5 [23 to 40.5]	34.4 [28 to 42]	34.7 [26 to 45]	35.1 [28 to 39]	36.4 [28.5 to 46.5]	35.6 [29 to 40]	3.2 [0 to 9.5]	0.6 [−5 to 9]	1.7 [−4 to 7]	0.5 [−6.5 to 4]
Symphysis width (D)	15 [11 to 20.5]	14.8 [11 to 18.5]	15.6 [12 to 21.5]	15 [11 to 18.5]	16 [12.5 to 23]	15.3 [12 to 18.5]	0.6 [−0.5to 2.5]	0.3 [−1.5 to 2.5]	0.4 [−1 to 2.5]	0.2 [0 to 1.5]

incisors have significantly less recessions than the central incisor. On the lingual side, tooth 32 presented lower risk of recessions compared to all other three incisors.

The frequency of recessions within patients presenting recessions at T0 increased from T0 to T2 for the buccal and the lingual side (Figure 2a and 2b).

Before the orthodontic treatment, only 1 per cent of the 'growing' patients presented one buccal or one lingual recession. At the post-retention time, 16 per cent of the patients had one to three buccal recessions and 8 per cent presented one, two or four lingual recessions (Figure 3a and 3b).

For the 'non-growing' patients, before the orthodontic treatment, already 15 per cent presented one or two buccal recessions and 4 per cent presented two lingual recessions. At T2, 50 per cent had one, two or three buccal recessions and 42 per cent had one to two lingual recessions.

Recession distribution according to age and gender

Recessions were statistically associated ($P < 0.05$) mostly with age (teeth 31, 32, 41, 42 both buccally and lingually) and gender (32 buccally and 42 lingually; Figure 4). The odds ratio (OR) for the presence of recessions in older versus younger patients ranged from 5.55 to 26.09 for the aforementioned teeth.

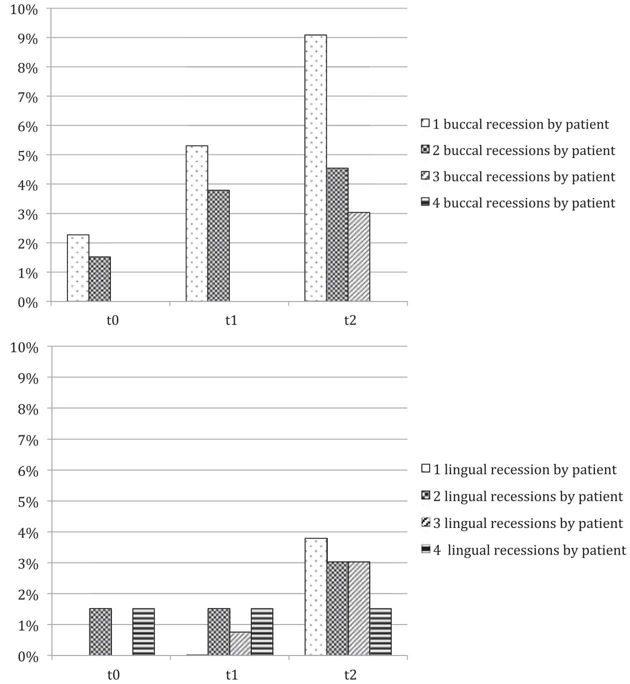

Figure 3. Evolution of the percentage of patients presenting 1 (dots), 2 (squares), 3 (hatches) or 4 (lines) of (a) buccal and (b) lingual recessions at T0, T1 and T2.

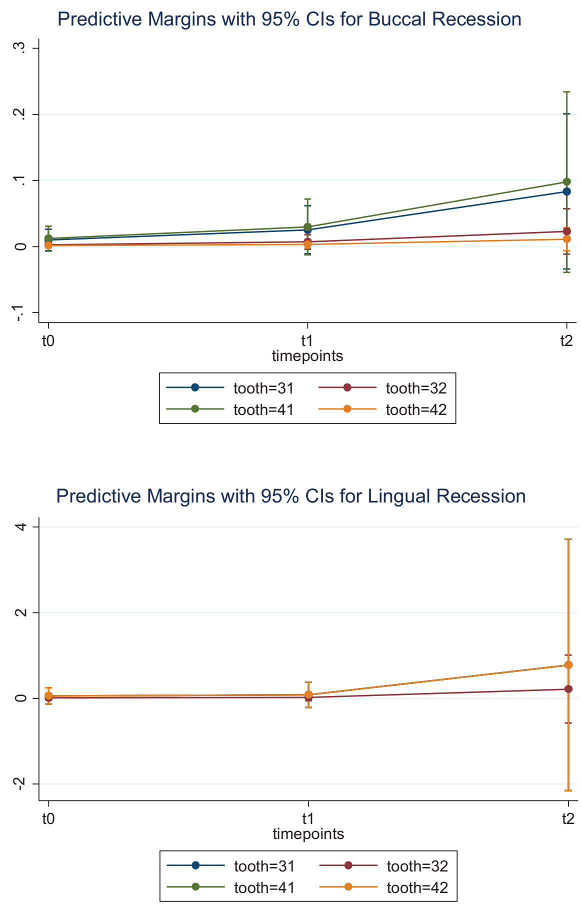

Figure 2. Predictive margins for (a) buccal and (b) lingual recession by teeth at T0, T1 and T2.

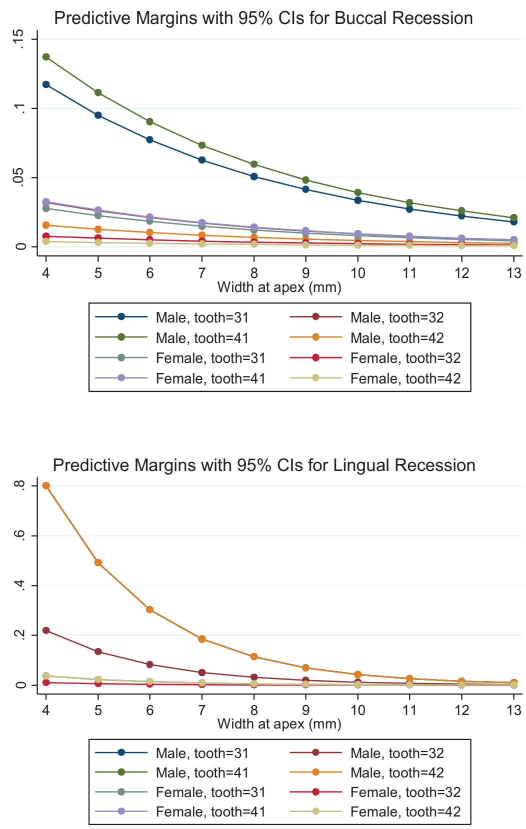

Figure 4. Predictive margins for (a) buccal and (b) lingual recession depending on the width of the alveolar bone process at the level of the apex for every lower incisors and genders.

Radiographic alveolar bone process width, symphysis heigth (Me-Wcrest) and width (D) and facial vertical skeletal pattern (AnsPns-Go'Me)

The width of the alveolar bone process at the apex (Wapex), at the level of the crest (Wcrest) and at mid of the root (Wmid) did not show any association with the development of buccal and lingual recessions.

The symphysis height (Me-Wcrest) was statistically related with the onset of lingual recessions on 32 [OR: 1.31, 95% confidence interval (CI): 1.03, 1.67, $P = 0.03$] and 42 (OR: 1.24, 95% CI: 0.99, 1.55, $P = 0.06$).

Neither the symphysis width (D) nor the vertical skeletal pattern (AnsPns-Go'Me) demonstrated any statistical association with the development of recessions.

Ratio symphysis height/width at the crest level

The ratio between the symphysis height and the width at the crest level demonstrated a weak association with the presence of buccal recessions on 32 (OR: 4.42, 95% CI: 1.13, 17.3, $P = 0.03$) and with the onset of lingual recessions on 41 (OR: 2.27, 95% CI: 0.88, 5.9, $P = 0.09$) and 42 (OR: 7.4, 95% CI: 1.58, 34.59, $P = 0.01$).

Thickness of the alveolar process on dental casts

The thickness of the alveolar process was measured only after treatment (T1). The mean thickness was 8.5 mm [standard deviation (SD) = 0.6 mm] at the level of the 32, 8.1 mm (SD = 0.7 mm) at the 31, 8.1 mm (SD = 0.7 mm) at the 41 and 8.6 mm (SD = 0.7 mm) at the 42.

'Growing' and 'non-growing' individuals presenting simultaneously lingual and buccal recessions had a thinner mean alveolar process thickness (8.2 and 7.9 mm, respectively) than recession-free individuals (8.4 and 8.3 mm, respectively) (Table 3).

Change in incisor inclination

The change in the incisor inclination demonstrate only associations with the onset of buccal recessions on tooth 31 (OR: 1.12, 95% CI: 1.01, 1.23, $P = 0.03$). Patients with buccal or lingual recessions presented a mean incisor inclination change of 3 degrees (range: −9 to 23 degrees), while the patients without recession have a 2.7 degree (range: −10 to 18 degrees) inclination change. In order to control if the pronounced proclination of 10 degrees or more could cause gingival recession, we observed the 16 patients with such incisor proclination (range: 10 to 23 degrees) and found 12 individuals without any recession and four with recessions (total of six buccal and five lingual recessions, mean number of two recessions) either labially or lingually.

Table 3. Mean alveolar process thickness mesured on dental casts at T1 on patients without recession, with only buccal recession, with only lingual recession, with simultaneously buccal and lingual recession and with minimum one recession on the buccal or on the lingual side compared with patients without recessions (standard deviation)

Mean alveolar process thickness (mm) on patients with:	<20 years old	>20 years old
No recession ($n = 81$ and $n = 11$)	8.4	8.3
Buccal recession ($n = 11$ and $n = 4$)	8.5	7.6
Lingual recession ($n = 3$ and $n = 2$)	8	8.5
Simultaneously buccal and lingual recessions ($n = 5$ and $n = 9$)	8.2	7.9
Buccal and/or lingual recession ($n = 14$ and $n = 24$)	8.4	7.9

Discussion

In the present study, the number of buccal recessions during orthodontic treatment as well as buccal and lingual recessions during retention phase increased within patients with time. Our findings could not support the hypothesis that the width of the alveolar bone process at the apex (Wapex), at the level of the crest (Wcrest) and at mid of the root (Wmid), the symphysis width (D) and the vertical skeletal pattern (AnsPns-Go'Me) is a predictor of the development of buccal and labial recessions. The symphysis height (Me-Wcrest) was statistically related with the onset of lingual recessions on 32. The ratio between the symphysis height and the width at the crest level demonstrated a statistically significant association with the presence of buccal recessions on 32 and with the onset of lingual recessions on 41. The change in the incisor inclination demonstrated only associations with the onset of buccal recessions on tooth 31.

The presence of recessions was not equally distributed in all four lower incisors. Buccally, lower central incisors presented more recessions than the laterals. This is in line with the findings by Pandis *et al.* (21) who observed that the left central incisor had more buccal recessions than the other incisors. We could consider that the frontal position of the two lower central incisors in combination with an inappropriate tooth brushing technique or the use of a hard toothbrush could explain these findings. At the lingual aspect, tooth 32 was found to be less susceptible to developing recessions than the other incisors. A possible explanation is that 90 per cent of the population is right-handed (25) and, thus, the 32 could be better protected from unfavourable forces applied during tooth brushing.

Our findings indicate that the frequency of gingival recessions was higher in males than in females. This is in line with the results of Albandar and Kingman (26) and Gorman (27). However Djeu *et al.* (19) and Ruf *et al.* (20) did not find significant differences between the two genders.

Before the start of orthodontic treatment, the age range of our sample was 11.5 years old (range: 8–19.2 years old) for the 'growing' group and 32.4 years old (range: 20.1–46.5 years old) for the 'non-growing' group. Before treatment, after treatment and at post-retention time, recessions were mainly present in the older study participants. We found that the risk of recessions was significantly associated with patient age as also described by Thomson *et al.* (28) and Murray (29). It has been postulated that this finding is associated with the cumulative effect of aggressive brushing techniques, microbial action, smoking and the progression of periodontal disease.

In our study, all but two patients received after treatment a lower lingual bonded retainer. Thus, our findings are in line with those of Pandis *et al.* (21), where an increase in the number of buccal and lingual recessions was observed. They argue that the presence of a fixed retainer increased the calculus, which possibly contributed to the increase in the number of lingual recessions.

However, a closer look on individuals who developed simultaneously buccal and lingual recessions shows that these individuals present a thinner alveolar bone process measured on dental casts than patients without recessions. Our method to measure the alveolar process thickness on dental cast includes the lingual and buccal gingiva and alveolar bone, the periodontal membrane and the root. Thus, we cannot comment on how much each of these tissues has possibly influenced the onset of recessions. We consider that the thickness of the gingiva may characterize individuals with different gingival biotypes (30). Given that no association was found between the cephalometrically measured alveolar process thickness and the development of recessions, we can deduce that individuals with thin alveolar process, measured on the dental casts, are more susceptible to develop gingival recessions because of possible thin gingival biotype, which provides a weaker support in the progress of recession caused by external etiologic factors.

The present study is retrospective, with non-homogeneous sample and treatment procedures. Some patients had just a short one-phase treatment, while others received a two-phase treatment and therefore were considered under treatment for many years, but all of them had at least one phase of fixed appliance. Furthermore the patients of our sample presented a large age variation and various types of malocclusions. Some adjustments were implemented in the analyses in order to account for those potential confounders. Despite this heterogeneity of our sample, we could identify certain anatomic features of individuals, which are linked to the development of recessions.

Conclusion

Excessive proclination (≥10§) of lower incisors during treatment may affect the development of gingival recessions. The vertical facial morphology was not associated with the development of new recessions. There was evidence that the width of the alveolar bone process measured on the lateral cephalograms as well as the thickness of the alveolar process measured on dental casts are associated with the development of recessions.

Conflict of interest

None to declare.

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