No association between gingival labial recession and facial type


*Department of Orthodontics, Palacky University, Olomouc, Czech Republic, **Department of Orthodontics and Craniofacial Biology, Radboud University Medical Centre, Nijmegen, The Netherlands, ***Department of Orthodontics and Dentofacial Orthopedics, University of Bern, Switzerland

Correspondence to: Piotr S. Fudalej, Department of Orthodontics and Dentofacial Orthopedics, University of Bern, Freiburgstrasse 7, 3010 Bern, Switzerland. E-mail: piotr.fudalej@zmk.unibe.ch

Summary

Objective: To evaluate if facial type is a predictor of the development of gingival recession.

Methods: A cohort of 179 orthodontic patients (76 males, 101 females; age before treatment $T_S = 12.4$ years, SD = 0.8) were followed until 5 years post-treatment ($T_5 = 20.7$ years, SD = 1.2). The presence of recessions was scored ('Yes' or 'No') by two raters on initial ($T_S$), end of treatment ($T_0$), and post-treatment ($T_5$) plaster models. A recession was noted (scored 'Yes') if the labial cemento-enamel junction was exposed. The clinical crown heights were measured at $T_S$, $T_0$, and $T_5$ as the distances between the incisal edges and the deepest points of the curvature of the vestibulo-gingival margins. Determination of the facial type was based on the inclination of mandibular plane relative to cranial base (Sella-Nasion/Mandibular Plane) and the proportion of posterior to anterior face heights (PFHs; SGo/NMe × 100 per cent) on pre-treatment cephalograms.

Results: From $T_0$ to $T_5$, the number of subjects with recessions increased from 2 (1.1 per cent) to 24 (13.6 per cent), and the number of recession sites increased from 2 to 39. However, most patients had either one or two recession sites. The mean clinical crown height of mandibular incisors increased by 0.86 mm (SD = 0.82, $P < 0.001$). Regression analysis showed that mandibular plane inclination had no effect on the development of gingival recession or on the increase of clinical crown heights of mandibular incisors.

Conclusions: Facial type is not a predictor of the occurrence of gingival recession.

Introduction

The development of gingival recession can be linked to previous orthodontic treatment (1, 2). Slutsky and Levin (1) found that the proportion of young adults (18–22 years of age) with recessions was more than twice as high in subjects who were treated orthodontically in the past (23 per cent) than in those who were not treated orthodontically (11 per cent). Also Renkema et al. (2) found that labial gingival recession is more prevalent in orthodontic patients than in untreated orthodontically subjects and the odds ratio to have recession is almost 4.5 for orthodontic patients as compared with controls. The authors also found that mandibular incisors are relatively most vulnerable to the development of gingival recession. Recessions are unesthetic, easily noticeable by the patient, and can cause discomfort. Therefore in a case of severe recession the risk of orthodontic malpractice litigation is increased (3).

The aetiology of gingival recession, particularly the role of mandibular incisor inclination, is not clear. Early animal experiments (4, 5) indicated that significant anterior movement of lower incisors resulted in alveolar bone loss and could lead to gingival recession. Batenhorst et al. (4) found that aggressive incisor proclination followed by a phase of spontaneous extrusion caused apical migration of epithelial attachment on the labial aspect of proclined teeth in Rhesus monkeys. This was accompanied by formation of alveolar...
dehiscences. Steiner et al. (5) reported similar findings—loss of marginal bone, loss of connective tissue attachment, and ensuing gingival recession—following labial incisor displacement also in monkeys. Clinical studies, in turn, provided equivocal evidence for the relationship between incisor position and gingival recession—some showed that such a relationship, although weak and probably clinically irrelevant, exist (6, 7), while others did not confirm this association (8, 9).

None of these studies considered, however, that the proclination of mandibular incisors in subjects with thin alveolus could promote the occurrence of gingival recession, whereas the comparable degree of proclination in subjects with thick alveolus could be harmless.

Numerous studies confirmed an association between morphology of the alveolar process of the mandible and facial vertical proportions (10–16). Overall, in subjects with a long facial type (also known as hyperdivergent or high-angle), the symphysis is slender and high and the alveolar bone is thin. In contrast, subjects with a short facial type (also known as hypodivergent or low-angle) have shorter symphysis and thicker alveolar bone. If an incisor in a person with long facial type, hence narrow and high mandibular symphysis, is proclined it may lead to progressive bone loss of alveolar cortical plates (17). As a result gingival recession can develop.

The objective of this study is to test a research hypothesis that facial type is associated with the development of gingival recession in a cohort of patients in whom mandibular incisors were proclined during orthodontic treatment.

Material and methods

This was a retrospective cohort study comprising orthodontic patients followed from the start of treatment ($T_0$) until 5 years ($T_5$) after completion of orthodontic therapy.

Subjects

The cohort was selected from the post-treatment archive at the Department of Orthodontics and Craniofacial Biology, Radboud University Nijmegen Medical Center, Nijmegen, the Netherlands, based on the following inclusion criteria: (1) from 11 to 14 years of age at start of orthodontic treatment ($T_0$), (2) all mandibular incisors were fully erupted before treatment, (3) none of incisors was extracted during treatment, (4) a fixed canine-to-canine retainer was attached directly after active orthodontic treatment with full fixed appliances, (5) no visible wear of incisal edges, (6) no orthodontic retreatment, and (7) dental casts and lateral cephalometric radiographs available before treatment ($T_0$), immediately after treatment ($T_1$), and 5 years later ($T_5$). Exclusion criteria were: (1) combined orthodontic/surgical treatment, (2) restorative treatment of mandibular incisors after orthodontic therapy, (3) dental casts of poor quality, particularly in the area of gingival margin, and (4) cephalograms of poor quality.

Demographic data such as gender and age during observation ($T_0$, $T_{5s}$, and $T_5$) were obtained from patient files. All subjects were treated with fixed appliances in both dental arches but the type of appliance (i.e., slot size, manufacturer, etc.) or wire sequence used could not be determined. Study size analysis was not performed before the investigation. Instead, all eligible subjects were included in the study.

Methods

Two types of orthodontic records—lateral cephalometric radiographs and dental casts—were evaluated. Lateral cephalograms were used to establish (1) facial type and (2) mandibular incisor inclination relative to mandibular plane, while dental casts were used to assess (3) the change of clinical crown heights and (4) the presence of gingival recession.

Overall, three facial types (short, average, and long face) are identified in orthodontic patients. This is usually done based on the inclination of mandibular plane angle relative to cranial base or based on the proportion of posterior facial height (PFH) to anterior facial height (AFH). To this effect, the following landmarks were identified and traced on pre-treatment (i.e., taken at $T_0$). lateral cephalogram: ‘sella’ ($S$, the center of sella turcica), ‘nasion’ ($N$, external point of the junction between nasal and frontal bones), ‘menton’ ($M_e$, the lowest point of the mandibular symphysis), ‘gonion’ ($G_o$, the most inferior posterior point of the mandibular angle), ‘edge’ ($L_1e$, incisal edge of the mandibular incisor), and ‘apex’ ($L_{1a}$, apex of the mandibular incisor). The ‘inclination of the mandibular plane relative to cranial base’ [$S$-Nasion/Mandibular Plane (SN/MP)] was determined as the angle between the line connecting $S$ and $N$ and the line connecting $M_e$ and $G_o$ landmarks; the ‘proportion of posterior to anterior facial heights was determined as the proportion of distances between $S$ and $G_o$ (PFH) and between $N$ and $M_e$ (AFH) $\left(\frac{\text{sella} - \text{gonion}}{\text{nasion} - \text{menton}} \times 100\%\right)$. The inclination of the mandibular incisor relative mandibular plane was measured as the angle between the line connecting $L_{1e}$ and $L_{1a}$ landmarks and the line connecting $M_e$ and $G_o$ landmarks.

The ‘clinical crown heights’ were determined as the distances between the incisal edges and the deepest points of the curvature of the vestibulo-gingival margins. The clinical crown heights were measured on the plaster models made at pre-treatment, at the end of treatment, and 5 years later (at $T_0$, $T_{5s}$, and $T_5$, respectively) for all mandibular incisors. The measurements were made with a digital caliper (Digital 6, Mauser, Winterthur, Switzerland) with an accuracy of 0.01 mm.

The presence of gingival recession before treatment, at the end of treatment, and 5 years post-treatment (at $T_0$, $T_{5s}$, and $T_5$, respectively) was scored as ‘Yes’/’No’ on the plaster models. A recession was scored ‘Yes’ if the labial cemento-enamel junction was exposed. The methods of measurements on dental casts were described and validated in our previous study (8).

Statistical analysis and method error assessment

Descriptive statistics (means and standard deviations) were calculated. Paired $t$-tests were used to assess the change of clinical crown heights after treatment (from $T_0$ to $T_5$). Pearson product-moment correlation coefficients were calculated to assess dependence between the SN/MP and proportion of facial heights, and between the SN/MP and mandibular incisor inclination. Regression analysis was performed to demonstrate the effects of pre-treatment ($T_0$) age, gender, SN/MP, and mandibular incisor inclination (independent variables) on the change of clinical crown heights from $T_0$ to $T_5$ (dependent variable) in mandibular incisors.

To verify the reliability of determination of facial type, 25 cephalograms were selected at random, retraced, and remeasured. The bias was assessed with Bland-Altman plots (Figure 1). The method error for measurements of incisor inclination, clinical crown heights, and scoring recessions was reported in our previous study (8). In general, the error was small. For example, the error during clinical crown heights determination was as follows: all coefficients of reliability were greater than 0.970, the duplicate measurement error ranged from 0.07 to 0.17 mm, the systematic error (found for some measurements) was less than 0.04 mm. The kappa ($\kappa$) statistics used
The mean SN/MP in the cohort was 35.3° (SD = 5.8°). This was slightly more with the normative value of SN/MP for Dutch population, which is 33° (SD = 3.3°) (18). A larger standard deviation in our cohort in comparison with the sample described by Prahl-Andersen et al. suggested that patients with high facial types were more prevalent in the current group than in a Dutch population. The mean proportion of facial heights was 67.2% (SD = 5.2%; range from 52.2 to 77.3) and was highly correlated with the SN/MP angle (correlation coefficient = −0.95).

The initial (T₀) inclination of mandibular incisors was inversely correlated with the SN/MP (correlation coefficient = −0.46). It means that the incisor inclination before treatment was larger in subjects with short facial type than in subjects with long facial type. The mandibular incisor inclination increased during orthodontic treatment by 4.9° and remained largely unchanged for the next 5 years (T₀ to T₅). Despite the moderate correlation between the initial incisor inclination and SN/MP, the change of inclination of mandibular incisors during treatment was weakly correlated with the SN/MP angle (correlation coefficient = −0.11). It suggests that the facial type (SN/MP angle) explained only 1.2% per cent of variance of the change of inclination of mandibular incisors during orthodontic treatment.

Casts evaluation
During a 5 year post-treatment period (T₀ to T₅), the number of subjects with recessions increased from 2 (1.1 per cent) to 24 (13.6 per cent), and the number of recession sites increased from 2 to 39 (Table 2). Most patients had either one or two recessions sites, and only four subjects had more than two recession sites. The mean clinical crown height of mandibular incisors increased by 0.86 mm (SD = 0.82, P < 0.001); Table 3. Regression models showed that mandibular plane inclination had no effect on the development of gingival recession sites (Table 4) or on the increase of clinical crown heights of mandibular incisors (Table 5) when pre-treatment age, gender, initial crown height, and post-treatment incisor inclination were controlled.

Discussion
Facial type and recession
In this study, we tested a hypothesis that the development of gingival recession in incisor region of the mandible is associated with a facial type determined by the mandibular plane inclination. The inclination of mandibular plane is an important factor affecting the planning of orthodontic treatment. It was shown that subjects with steep mandibular plane (i.e. long facial type) could have different growth characteristics (19) or therapeutic response (20, 21) than subjects with flat mandibular plane (i.e. short facial type). Importantly, a steep mandibular plane is frequently associated with slender alveolar process, while flat mandibular plane is often related with thick alveolar process and prominent bony chin (10). We hypothesized that if mandibular incisors are proclined during orthodontic treatment in a patient with steep mandibular plane, it could lead to thinning of labial aspect of the alveolus and could result in the development of gingival recession. This was demonstrated in a group of patients with mandibular overgrowth in whom mandibular incisor proclination was a part of orthodontic preparation before orthognathic surgery (22). In these subjects, mandibular plane is frequently steep and lower PFH is excessive (23). Compensatory mechanisms cause that the mandibular symphysis elongates and is narrow, incisors are retroclined, and alveolar bone is thinner than in other types of malocclusions. In such environment, orthodontic deceleration of the teeth performed before surgical correction of malocclusion can lead to further thinning of alveolar bone, dehiscence formation, and gingival recession (22, 24). In contrast, our findings showed that in a cohort of non-surgical patients with Class I and Class II malocclusion the development of gingival recession or the increase of clinical crown heights of mandibular incisors were not dependent on the mandibular plane angle (i.e. facial type). We found that both periodontal parameters demonstrated the lack of association with the facial type when mandibular incisor inclination, age, and gender were controlled for. In other words, high-angle patients in whom mandibular incisors were proclined during orthodontic treatment have the same chance of the development of gingival recession as low-angle-patients in whom incisors were not proclined.

Facial type and incisor inclination
The facial type is related with inclination of mandibular incisors—the steeper the mandibular plane, the smaller the angle between the axis of mandibular incisors and mandibular plane and vice versa—the
Mandibular incisor inclination at $T_1$ (degrees) 93.2 7.2 68 117.8
Mandibular incisor inclination at $T_5$ (degrees) 98.1 6.8 73.5 125.8
Mandibular incisor inclination at $T_s$ (degrees) 99 7.2 74.5 119.2

Table 2. Gingival recessions in the region of lower incisors pre-treatment ($T_0$), at the end of treatment ($T_s$), and 5 years ($T_5$) after treatment.

<table>
<thead>
<tr>
<th>Subjects</th>
<th>$T_s$</th>
<th>$T_0$</th>
<th>$T_5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>N without recessions</td>
<td>177</td>
<td>175</td>
<td>153</td>
</tr>
<tr>
<td>N with recessions</td>
<td>0</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>% with recessions</td>
<td>0</td>
<td>1.1</td>
<td>13.6</td>
</tr>
<tr>
<td>N with one recession</td>
<td>—</td>
<td>—</td>
<td>2</td>
</tr>
<tr>
<td>N with two recessions</td>
<td>—</td>
<td>—</td>
<td>8</td>
</tr>
<tr>
<td>N with three recessions</td>
<td>—</td>
<td>—</td>
<td>2</td>
</tr>
<tr>
<td>N with four recessions</td>
<td>—</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>N with five and more recessions</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Total number of recessions</td>
<td>0</td>
<td>2</td>
<td>39</td>
</tr>
</tbody>
</table>

Table 3. The increase (in millimetres) of mean clinical crown height of lower incisors after treatment (from $T_0$ to $T_s$) assessed with paired $t$-tests.

<table>
<thead>
<tr>
<th>Tooth number</th>
<th>Increase of crown height</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>1.02 (0.84)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>31</td>
<td>0.73 (0.82)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>41</td>
<td>0.74 (0.84)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>42</td>
<td>0.95 (0.73)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mean</td>
<td>0.86 (0.82)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Length of follow-up

In the present investigation, we analysed the periodontal condition 5 years after orthodontic treatment. The length of observation period was dictated by the system of follow-up introduced at the Department of Orthodontics and Craniofacial Biology, Radboud University Nijmegen, in 1970s. According to the system, patients were recalled 2, 5, and 10 years after completion of treatment. It is well known, however, that the longer the time between the end of treatment and the moment of a recall appointment, the higher the drop-out rate. Ärtun and Krogstad (24) stated that the development of gingival recession took place during or shortly after orthodontic treatment. Thus a 5 year follow-up was assumed to be a sensible compromise between the possibility to accumulate large sample with the minimum drop-out rate and the time needed to observe the effect of examined variable (here—the facial type) on the development of gingival recession and the increase of clinical crown height. We confirmed that this assumption held true in the other study (2), in which we found a statistically significant difference in the prevalence of gingival recession between orthodontic patients and untreated orthodontically controls already at 18 years of age. Nevertheless the issue of optimal, i.e. neither too short nor too long, follow-up period has not been resolved. Theoretically, if the development of gingival recession is influenced mainly by factor(s) present during orthodontic treatment, the follow-up period should not be too long because the natural, i.e. unrelated with orthodontic therapy, development of gingival recession can mask the gingival recession promoted by orthodontic mechanotherapy. On the other hand, it is possible that orthodontic treatment along with retention phase creates a changed environment (e.g. thinning of the labial plate of alveolar bone) during the treatment, which induces or accelerates the occurrence of gingival recession ‘afterwards’. In such a situation the follow-up should be extended. So the choice of the length of observation period can depend on the research question tested in a study.

Limitations

This is a retrospective study and can have limitations related to selection bias. Selection bias occurs when study participants are not representative of the population of interest. In this study, the sample was recruited from a specific orthodontic department, which may limit the generalizability of the findings. Additionally, the follow-up period of 5 years might not be long enough to capture all possible gingival recessions, especially if the development of gingival recession is influenced by longer-term factors. However, the sample size and the methodological approach used in this study provide a solid foundation for further research in this area.
systematically different from eligible but not included participants. It cannot be ruled out that the prevalence or distribution of gingival recession in patients attending 5 year post-treatment recall visit and selected for this study was different than in a population of orthodontic patients at large. However, the large sample size and inclusion of consecutively treated patients should have reduced a potential for selection bias. Furthermore, we evaluated here if the mandibular plane inclination (i.e. facial type) is related with the development of gingival recession. We based our hypothesis on numerous studies showing that the inclination of the mandibular plane is related with thickness of the alveolar bone. However, we did not make direct measurements of the alveolus and it is possible that some of them might be related with deterioration of periodontal condition. However, for a clinician, an establishment of a relationship between the facial type and gingival recession is sensible because the determination of facial type is easy and routinely performed and had it been associated with gingival recession it could have had a significant prognostic value.

In conclusion, the inclination of the mandibular plane relative to cranial base is not associated with the development of gingival recession. Therefore it cannot be used as a risk factor for occurrence of gingival recession.

Acknowledgements
We would like to thank Dr Ewald Bronkhorst from Radboud University Medical Centre, Nijmegen, the Netherlands, for statistical analysis.

References