Postretention change of overbite as related to incisal inclination and position

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A dissertation submitted for fulfilment of master degree as part of the orthodontic postgraduate program

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DECLARATION
This thesis has not been submitted elsewhere for any other Degree or Qualification. Except where acknowledged this thesis is my original work.

SIGNATURE:

DATE:
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ABSTRACT

AIM: to investigate post-treatment overbite relapse as related to incisal inclination and interocclusal position changes (according to Backlund’s index, 1958). Furthermore, to identify cephalometric variables for prediction of posttreatment overbite relapse.

MATERIAL AND METHODS: Study models and roentgen-cephalograms from 97 orthodontically treated patients were analysed in regard to
- Incisal inclination and interocclusal position on the palatal surface of the upper incisors (Backlund’s index, 1958)
- Vertical skeletal relation before treatment (T1), at retention (T2) and at post-retention at age of 19 years (T3).

RESULTS: There was a significant overbite change at T3 compared to T2 (p < 0.05). No correlations could be found between the overbite relapse at T3 and incisor inclination, interincisal angle, interocclusal position, or with any other variables at T2. At T1, none of the included variables except ML/NSL and interocclusal position 4 (Backlund’s index) could predict overbite relapse at T3 (p < 0.05).

CONCLUSIONS: This study indicates that the orthodontic treatment outcome, as far as interincisal relation, incisal inclination and interocclusal position are concerned, is not related to the long term overbite relapse. Dentitions characterized by an initial low mandibular plane angle and a gingivally located lower anterior occlusal position (Backlund’s index 4) are prone to overbite relapse.
INTRODUCTION

The overbite is defined as vertical overlapping of the anterior incisors with the average of being equal to one third the length of the maxillary incisor crown (Strang 1934, 1950).

During the past 10,000 years of the history of mankind, this definition has changed. Due to an altered lifestyle from hunting to agriculture and the transform to the industrial world, the dental occlusion has adopted to the environmental need. The overbite such as the contemporary definition above only existed in the ancient population immediately after the eruption of the permanent teeth. With extensive tooth wear due to non-processed food, it was then soon after, to edge to edge relationship. (Thilander et al 1991, Varrela 1992, Kaifu 2000).

Rowlett et al (1923) described the incisors of primitive man occluding in an edge-to-edge relationship with the molars in normal occlusion. The vertical overlapping, known as “overbite” has prevailed since only 2000 years ago and is believed to be due to transformation to the civilized diet (Rowlett et al 1923).

In the ancient populations, the edge to edge anterior occlusion was due to the tooth wear and its effect on interproximal wear creating spaces. Lingual tipping of anterior teeth to an edge to edge relationship was to compensate and maintain the contacts between adjacent teeth (Kaifu, 2000, Silness et al 1993).

The prevailing definitions of contemporary malocclusions are dynamic and the norms of what is believed to be ideal, might change in the future (Kaifu 2000).
In the study of Moyers (1960), it is claimed that there is no complete agreement on the normal range of overbite and that it may vary with the age and facial pattern and time.

An important criteria for a successful orthodontic treatment result, is to achieve a normal overbite and to maintain it permanently. The overbite in long-term is dependent on several factors. According to Backlund (1958) one of the causes of the increased overbite is the inclination of the upper and lower incisors in relation to their supporting jaw bone and to each other. Retroclined incisors give rise to an enlarged interincisal angle with poor vertical support for the anterior occlusion. The anterior teeth may therefore reach excessive vertical levels and overlapping. Eruption goes on until the vertical growth force of the alveolar bone has ceased or is balanced by masticatory axial forces or forces exerted by soft tissue or until impingement of the gingival tissues occurs. The incisor angle is by definition of Backlund (1958) the angle formed by lower incisors with the lingual surface of upper incisors. Another major assumable factor of importance for stabilization of the incisors, is the morphology of the horizontal plateau, the so called cingulum of the upper incisors. The extent of this plateau and its morphology are important, to allow contact with the lower incisors and balance for small lateral and forward movement (Backlund 1958).

To increase the vertical stability, it would then be important to pay attention to a proper finishing of the incisor angle and interincisal relation during orthodontic treatment.

Payne et al (1964) investigated the relation of overbite change to post-retention growth, indicating that post-retention ramus growth tended to
decrease the mandibular plane angle, resulting in increased posterior facial height and forward positioning of the symphysis and therefore considered this phenomenon as partially responsible for overbite relapse.

There have also been studies about different treatment modalities such as the role of extraction versus non extraction on the stability of the overbite. Hernandez et al (1969) found greater incidence of relapse in an extraction than a non extraction sample.

Magill (1960) found that one half of the overbite relapse occurred within two years out of retention. There was no significant difference with regards to different Angle classes of malocclusion or mode of treatment when it comes to extraction versus non extraction.

Bishara and Jakobsen (1998) indicate that despite significant correlations between overbite and facial height based on untreated long-term follow up of 40 years, they are low and not useful for predictive purposes. They claimed that normal growth changes in the vertical dimension of the face, does not play a clinically significant role in determining the amount of the overbite on an individual. Other factors such as growth of the alveolar processes might also influence changes in overbite.

The relation of the upper incisors to the lower incisor is of great importance as they erupt towards each other to their final position which is determined by their inclined planes. This inclined plane regulates the lower incisors, by which angle they meet the upper incisors “the incisal angle” and where they occlude on the lingual surface of the upper incisors. Therefore there might be a stabilizing area where the lower incisors will occlude optimal with the upper incisors (Backlund 1958). Finding the best interrelation between the
upper and lower incisors would help to maintain the orthodontic treatment results. Mills (1966) stated that the lower incisors lay in a narrow zone of stability in equilibrium between the opposing muscular pressure, that of their labio-lingual position should not be altered dramatically. Reitan claimed that tipping of the incisors labially or lingually during orthodontic treatment will most likely relapse (Reitan 1969).

Adequate interincisal contact and angle with good posterior intercuspiddation may prevent overbite relapse (Kahl-Nieke et al 1995, Reitan 1969 and Shudy 1974).

The purpose in this study therefore, is to examine whether the incisor inclination and position and their interrelation at retention, is related to the overbite relapse at postretention and if so, what would be the most stable relation and inclination of the incisors at the final treatment. Another purpose of the study is to identify if there are any predictive factors for the overbite relapse at postretention and if so can those patients prone to relapse be identified at the initial treatment phase in an orthodontic practice.

The aim of the study is to investigate post-retention overbite change related to incisal inclination and interocclusal position.

**MATERIAL AND METHOD**

The material consists of 97 patients with full records of study casts and lateral cephalograms from a group of randomized 1554 orthodontic patients reaching to 520 treated by orthodontists in the city of Halmstad in southwest of Sweden. The patients were all treated by specialists in orthodontics with
fixed appliance with or without removable appliance as part of the treatment.

The sample of the study is ethically approved in prior studies (Lagerström et al 1998, 2000 and Berset et al 1998).

The material comprises of complete lateral cephalograms and study casts from the initiation of treatment T1, at retention T2 and at post-retention T3.

The mean (SD) age at the initial treatment T1 was 12.5 (1.5 years), at T2 14.5 (SD 1.5) and at T3 18.6 years (1.8 years).

Inclusion criteria:

- Swedish adolescent patient population in Halmstad
- No palatal or labial clefts, no facial trauma
- No diseases that could affect the growth
- Treatment being carried out in the Specialty Clinic of Halmstad with prior malocclusions of Angle class I, II, III with the presence/absence of crowding reflecting orthodontic patients in general, all with homogenous routines for treatment such as fixed appliances and retention such as two years after treatment and out of retention with control at the age of 19 years.
- Complete patient records, lateral cephalograms and available study models at all three stages such as pre-treatment T1, Posttreatment T2, Postretention T3.
- Post-retention of minimum 2 years
Study model analysis:

In order to compare the changes from post-treatment to post-retention, all the study models at all three stages were evaluated and measured with a digital caliper measuring the following variables by one observer:

- **Overbite:** as the greatest amount of vertical overlap of the incisors in centric occlusion

- **Anterior occlusion according to Backlund (1956),** as to where the lower incisors occlude on the lingual surface of the upper incisors:

  Grade 1 2 3 4 (FIG 1):
  
  1. the first part is the acutely inclined incisal part with inclination of 4° to axial line
  2. The plateau of cingulum with the 30° to axial line directly after the lingual surface curves called the border.
  3. The third and cervical part consists of convex surface represented by an angle 6° to axial line.
  4. Behind the tooth representing the palatal gingival.

![FIG. 1](image-url)
- Intercanine distance (the distance between the tip of the cusps)
- Irregularity index (Little 1975)
- Overjet: Amount of greatest horizontal overlap in centric occlusion

Cephalometric Analysis:
All cephalograms were performed with the same magnitude of magnification and in the same clinic in Halmstad using standardized procedures.
All three stages were measured by the same observer with manual digitizing using a mechanical pencil with 0.5 mm lead, tracing on a transparent sheet and a millimetric orthodontic ruler (FIG II.).

The following parameters were measured:

- Interincisal angle
- Upper incisor inclination to NL
- Lower incisor inclination to ML
- ANB
- ML/NSL
- ML/NL
10 randomly selected patients were recalculated and retraced by the observer and traced by another observer to control the intra-observer and inter-observer errors.

Statistics:
The statistical methods used, are the Dahlberg´s Method of Error, Wilcoxon Matched Pairs Test and the Multiple Correlation Analysis, conveyed with help of statistician Margareta Krook Brandt at the Karolinska Institutet. The significant level at $p < .050$ is used in this study.
RESULT

There was a significant overbite change at T3 compared to T2 (p < 0.005).
(Wilcoxon Matched Pairs Test p=0.032965)

No correlations could be found between the overbite relapse at T3 and incisor inclination, interincisal angle, interocclusal position, or with any other variables at T2.

At T1, none of the included variables except ML/NSL and interocclusal position 4 (Backlund´s index) could predict overbite relapse at T3 (p < 0.05).

Hereby the results are presented in table I and the following graphs:

TABLE 1.

Mean and SD of all the measured variables at T1, T2, and T3:

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>UNIT</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>MEAN</td>
<td>(SD)</td>
<td>MEAN</td>
</tr>
<tr>
<td>Overbite</td>
<td>mm</td>
<td>2.8</td>
<td>(1.8)</td>
<td>1.8</td>
</tr>
<tr>
<td>Backlund Index</td>
<td>1,2,3,4</td>
<td>3.8</td>
<td>(1.0)</td>
<td>1.8</td>
</tr>
<tr>
<td>Intercanine distance (Lower arch)</td>
<td>mm</td>
<td>26.6</td>
<td>(1.9)</td>
<td>26.8</td>
</tr>
<tr>
<td>Irregularity Index</td>
<td>mm</td>
<td>-2.2</td>
<td>(3.2)</td>
<td>-0.2</td>
</tr>
<tr>
<td>Overjet</td>
<td>mm</td>
<td>6.2</td>
<td>(9.9)</td>
<td>2.8</td>
</tr>
<tr>
<td>ML/NSL</td>
<td>°</td>
<td>28.3</td>
<td>(5.5)</td>
<td>27.9</td>
</tr>
<tr>
<td>ML/NL</td>
<td>°</td>
<td>32.5</td>
<td>(5.2)</td>
<td>32.4</td>
</tr>
<tr>
<td>ANB</td>
<td>°</td>
<td>4.4</td>
<td>(2.3)</td>
<td>3.8</td>
</tr>
<tr>
<td>U1/NL</td>
<td>°</td>
<td>110.2</td>
<td>(6.6)</td>
<td>109.1</td>
</tr>
<tr>
<td>L1/ML</td>
<td>°</td>
<td>95.2</td>
<td>(7.4)</td>
<td>95.9</td>
</tr>
<tr>
<td>Interincisal Angle</td>
<td>°</td>
<td>126.3</td>
<td>(11.2)</td>
<td>127.0</td>
</tr>
</tbody>
</table>
Vertical overbite at T1, T2, T3

Significant difference between T2 and T3, the vertical overbite relapse at retention and its change to postretention (p<0.05).

Vertical overbite change T2-T3 with ML/NSL at T1

ML/NSL T1:Diff T2-T3: \( r = -0.2272, p = 0.0252 \)
No correlations could be found between the vertical overbite relapse and all the measured variables as described above and in Table 1.

The null hypothesis of the study that final treated interincisal relationship, inclination and position will not interfere with the overbite stability was accepted in this study.

DISCUSSION

The incisor angle and the angle formed by the lower incisors with the lingual surface of upper incisors together with the morphology of the horizontal plateau, cingulum of the upper incisors where the lower incisors occlude, have been advocated for stability of the vertical dimension (Backlund 1958).

To increase the vertical stability, it has been suggested to pay attention to a proper finishing of the incisor angle and interincisal relation during orthodontic treatment.

Payne et al (1964) investigated the relation of overbite change to post-retention growth, indicating that post-retention ramus growth tended to decrease the mandibular plane angle, resulting in increased posterior facial height and forward positioning of the symphysis and therefore as partially responsible for overbite relapse.

There have also been studies about different treatment modalities such as the role of extraction versus non extraction on the stability of the overbite. Hernandez et al (1969) found greater incidence of relapse in an extraction than a non extraction sample. However in this study the prevalence of
extraction versus non-extraction did not imply any significant differential influence on overbite relapse.

Magill (1960) found that one half of the overbite relapse occurred within two years out of retention. There was no significant difference with regards to different Angle classes of malocclusion or mode of treatment when it comes to extraction versus non extraction. In this study the ANB angle did not have any relation with the vertical overbite relapse. Since the patients were followed up til the age of 19 years almost all patients were out of retention for a minimum of 2 years at T3. Bishara and Jakobsen (1998) indicate that despite significant correlations between overbite and facial height based on untreated long-term follow up of 40 years, they are low and not useful for predictive purposes. They claimed that normal growth changes in the vertical dimension of the face, does not play a clinically significant role in determining the amount of the overbite on an individual. Other factors such as growth of the alveolar processes might also influence changes in overbite.

Nanda and Nanda (1992) found that the prepubertal growth spurt for patients with skeletal deep bite occurs on average 1.5 - 3 years later than in cases with open bite. For this reason advocating a longer retention period for patients with skeletal deep bites, counteracts the effect of late dento-facial growth.

In the current study as the prior studies the only putative predictive significant factors for overbite relapse were, initial skeletal deep bite at T1 and/or Backlund index 4, meaning dentoalveolar deep occlusion with gingival impingement. These patients are susceptible to vertical relapse and
should be in retention and for a longer and monitored more often when out of treatment for retention controls. The patients and the parents should also be informed about the relapse risk in beforehand, when there is evident initial skeletal deep bite or when dentoalveolar deep bite with gingival impingement is present.

However it is important to bear in mind that the current study is retrospective with short term follow-up only to the age of 19 years. The patient groups are treated with fixed appliances with different treatment modalities and individual variations such as the initial malocclusion, growth pattern, patient compliance during treatment and final treatment results which make all more complicated. Long term follow-ups are difficult to convey since many of the patients move and are difficult to trace after 10-15 years. There are more favourable with long term studies in exposing the act of overbite change beyond the growth into adulthood.

Mills (1966) stated that the lower incisors lie in a narrow zone of stability in equilibrium between the opposing muscular pressure and that of their labio-lingual position should not be altered dramatically. Reitan claimed that tipping of the incisors labially or lingually during orthodontic treatment will most likely relapse (1969).

Adequate interincisal contact and angle with good posterior intercuspidation may prevent overbite relapse (Kahl-Nieke et al 1995, Reitan 1969 and Shudy 1974).

In this study the incisor inclinations, the interincisal angle and the interocclusal position at T2 did not demonstrate any statistical significant relevance to the overbite relapse.
As the sample of the study comprised of 97 patients it was adequate for statistical comparisons according to the statistician acquired to convey this study. However to have certain conclusions, this study should be conveyed as a prospective study with broader follow up.

The measurements were done by the same observer and 10 randomized patients were retraced by the observer and by another observer and the measurement were compared to access the accuracy in measuring and to access the intra and interobserver change. The error of the method was assessed by the Dahlbergs formula.

\[
ME = \sqrt{\frac{\sum d^2}{N}}
\]

The measurements did not differ from the acceptable range of 0,6 mm on linear measurements and 0,8 ° on angular measurements.

The accuracy of the measurements coincided well with the control measurements and is considered reliable and reproducible.

As individuals are different and there is a large variation it is also difficult to collect a large homogenous sample in one study.

The age of the patients in all three groups were within the same age ranges with small standard deviations, representing acceptable homogenous groups. This study implies that the incisor inclinations and interincisal relation and position might not play an important role for the overbite stability as believed before and that there are far more complex and multifactorial reasons behind together with the large variation of the growth.
CONCLUSION

There is a vertical relapse taking place from retention to postretention at the age of 19 years.

Overbite relapse was not affected by final incisor inclination, interincisal angle, interocclusal position at retention.

Overbite relapse is due to multiple factors more complex than the incisor inclination and position at the final treatment results.

Initial skeletal deep relation and initial dento-alveolar deep bite with gingival impingement at T1, were associated with vertical relapse at T3 and may be considered as putative predictive factors for vertical relapse.

Patient with the above mentioned diagnosis characteristics, should receive the correct retention, maintain their retention longer and monitored for post-retention controls with information of the risk for relapse.
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