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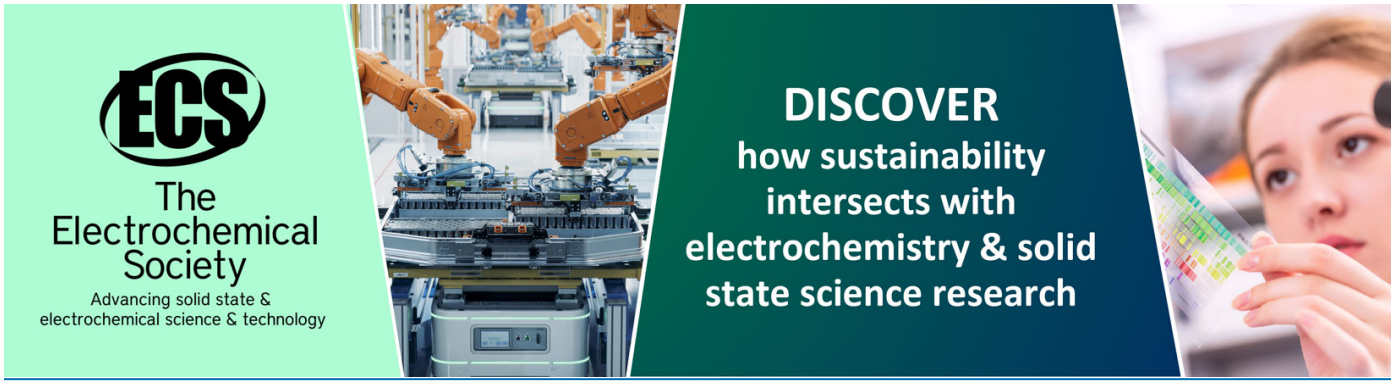

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Correlation in changes in the upper and lower incisor inclinations toward the nasolabial angle and mentolabial angle in non-extraction Class I malocclusion orthodontic treatment

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Abstract: Non-extraction orthodontic treatment in borderline cases is reported, according to some authors, to lead to upper and lower incisor inclination changes affecting patients' soft tissue profiles. Here, we aim to determine the correlation, in non-extraction Class I malocclusion cases, between the upper and lower incisor inclination changes toward the nasolabial angle and the mentolabial angle before and after orthodontic treatment. (We took before and after lateral cephalometric radiographs on 26 patients with non-extraction Class I malocclusion orthodontic treatment.) We measured the I-SN, IMP, nasolabial, and mentolabial angles. For statistical analysis, we used the non-parametric Wilcoxon test and the Spearmen correlation test. There was no significant difference between the I-SN and nasolabial angles, but a significant difference between the IMP and mentolabial angles, before and after treatment. The correlation test showed very weak negative and positive correlations between the change in the I-SN angle and the change in the nasolabial angle, and the change in the IMP angle and the change in the mentolabial angle, respectively. The decrease in the I-SN angle was followed by an increase in the nasolabial angle, even though the correlation was very weak. The increase in the IMP angle was followed by an increase in the mentolabial angle, which was also very weakly correlated.

1. Introduction

The achievement of harmonic facial esthetics, functionality, and structural balance of patients is the aim of orthodontic treatment [1]. Harmonic facial esthetics are important and need attention because they affect a person's degree of self-confidence to be expressive and held in high regard socially [2]. Esthetics are also the main motivation for patients considering orthodontic treatment [3-5]. The clinical standard parameters in planning orthodontic treatment are photography and cephalometric measurements [6]. The position of the lips related to the inclinations of the upper and lower incisors determines the lower third of a patient's profile. The inclination of the incisors is therefore an important factor that needs to be considered when determining the esthetics of a facial profile, the facial harmony of which is based on the balance in morphology and proportion between the nose, chin, and lips [7]. The nasolabial and mentolabial angles are important considerations when planning orthodontic treatment because the size of the angles contributes to the patient's profile [8].

For over a decade, tooth extraction in orthodontic treatment has been a topic of debate [9,10]. Some researchers argued that tooth extractions tend to produce a straight facial profile [11-13]. According to a study by Verma et al. comparing extraction and non-extraction orthodontic treatment on 100 female patients with borderline Class I malocclusion (50 patients with premolar extractions and 50 patients without extractions), extraction on Class I malocclusion cases showed a significant change in the soft tissues, such as the position of the lips and the nasolabial angle, whereas non-extraction treatments resulted in a significant retraction of the upper lip and protraction of the lower lip, followed by a 1.25° increase in the nasolabial angle post treatment [14]. A study by Kocadereli comprising 80 Caucasian patients with Class I malocclusion—40 patients with extraction and 40 patients with non-extraction treatments—showed retroclined maxillary and mandibular incisors during treatment of patients with extraction. However, the non-extraction group showed a significant forward change in inclination with a 3.3° decrease in the nasolabial angle post orthodontic treatment [10]. Erdinc et al. conducted a similar study with 98 teenage patients, in which 49 cases had extraction orthodontic treatment and 49 had non-extraction orthodontic treatment. Twenty-eight patients in each group (the extraction group and the non-extraction group) had Class I malocclusion and Class II division 1 malocclusion, respectively. No significant correlation emerged between the change in hard tissues and that in soft tissues post orthodontic treatment. These results were affected by the young age of the patients, who were still growing. Erdinc et al. conducted a similar study with 98 teenage patients, measuring the inclination of the upper incisors using the I-SN angle, in which 49 cases had extraction orthodontic treatment and 49 had non-extraction orthodontic treatment. Twenty-eight patients in each group (the extraction group and the non-extraction group) had Class I malocclusion and Class II division 1 malocclusion, respectively. No significant correlation emerged between the change in hard tissues and that in soft tissues post orthodontic treatment. These results were affected by the young age of the patients, who were still growing [15].

An Indonesian study on the change in mentolabial angle post Class I malocclusion non-extraction orthodontic treatment has not yet been done. Moreover, the difference between the study results obtained by Verma et al. and those obtained by Kocadereli on the change in nasolabial angle post non-extraction orthodontic treatment should be considered. We therefore aim to evaluate the nasolabial and mentolabial angles and their correlation with the inclination of the upper and lower incisors and to observe the changes in soft tissue facial profile accompanying post Class I malocclusion non-extraction orthodontic treatment in patients aged 18–40 years in the Orthodontic Specialists Clinic, Teaching Hospital of the Faculty of Dentistry, Universitas Indonesia.

2. Methods

This was an observational analytic study with a cross-sectional approach. The samples used in this study were lateral cephalograms of Teaching Hospital of the Faculty of Dentistry, Universitas Indonesia patients with Class I malocclusion fulfilling the following inclusion criteria:

1. Class I malocclusion/orthognatic non-extraction orthodontic treatment with maximum anchorage
2. aged 18–40 years old
3. with complete dentition until the second molar on the upper and lower jaws
4. with lateral cephalograms in good condition before and after treatment.

The exclusion criteria were patients with missing teeth.

Reliability test was performed in the form of inter-operator test between the researcher and the supervisor, and an intra-operator test after 1 week. The cephalograms were traced on a tracing paper using a 2H pencil and measured the angles using a protractor. The results of the tracing and measurement of the cephalograms were analyzed using the Wilcoxon non-parametric test and the Spearman correlation test. The Wilcoxon test was used to determine the difference before and after Class I malocclusion non-extraction orthodontic treatment in the inclinations of the upper and lower incisors

and the nasolabial and mentolabial angles of the cephalograms. The Spearman correlation test was used to find the correlations between the change in the inclinations of the upper and lower incisors and the change in the nasolabial and mentolabial angles.

3. Results

Inter-operator test was performed on 30% of the samples (nine pairs of before and after cephalograms). The unpaired T-test indicated that the tracing and measurement of the inclination of the upper and lower incisors—and also the nasolabial and mentolabial angles between the researcher and the supervisor—were not significantly different ($p > 0.05$). Intra-operator test was performed on 10% of the samples (three pairs of before and after cephalograms) using the paired t-test to determine the consistency of the researcher in tracing and measuring cephalograms after 1 week. The paired T-test indicated that the researcher was consistent in tracing and measuring cephalograms and had high reliability ($p > 0.05$).

Table 1. Difference in I-SN, IMP, nasolabial, and mentolabial angles before and after treatment

	Before treatment	After treatment	p
I-SN angle	108.73° ± 5.98°	105.31° ± 7.61°	0.058**
IMP angle	97.29° ± 6.40°	99.85° ± 6.70°	0.010*
Nasolabial angle	91.65° ± 9.12°	91.73 ° ± 10.82°	0.914**
Mentolabial angle	123.90° ± 14.39°	128.65° ± 12.23°	0.011*

*P < 0.05
**P>0.05

On the basis of the results presented in Table 1, there was no significant difference in the I-SN and nasolabial angles before and after treatment. In contrast, the changes in IMP angles and mentolabial angles before and after treatment were statistically significant ($p = 0.010$ and $p = 0.011$, respectively).

The Spearman correlation test was conducted to determine the correlation between the change in I-SN angles and the change in nasolabial angles, and the correlation between the change in IMP angles and the change in mentolabial angles.

Table 2. Correlation between the change in I-SN angles and the change in nasolabial angles, and correlation between the change in IMP angles and the change in mentolabial angles

	r	p
I-SN angle–Nasolabial angle	−0.043	0.835**
IMP angle–Mentolabial angle	−0.021	0.920**

**P>0.05

The results presented in table 2 show that, in Class I malocclusion non-extraction orthodontic treatment, there is a very weak negative correlation between the change in I-SN angles and the change in nasolabial angles, which is not statistically significant, and there is a very weak negative correlation between the change in I-SN angles and the change in nasolabial angles, which is not statistically significant.

4. Discussion

This study aimed to determine whether there was a difference between the soft tissue profiles using the evaluation of the nasolabial and mentolabial angles and their correlation with the inclination of the upper

and lower incisors after fixed orthodontic treatment of patients with Class I malocclusion non-extraction cases. Data of patients with Class I non-extraction orthodontic treatment at the Orthodontic Specialist Clinic of Teaching Hospital, Faculty of Dentistry, Universitas Indonesia, were obtained by tracing and measuring 26 pairs of cephalograms taken before and after treatment. Subjects were chosen between the ages of 18 years and 40 years to exclude patients influenced either by growth factors (in patients aged below 18 years) or by aging factors (in patients aged over 40 years). The subjects of this study mostly consisted of the Deutero Melayu race.

In evaluating the inclination of the lower incisors, the IMP angle was used because it is not determined by vertical changes of the mandibular jaw. The IMP is an angle in the Tweed triangle in angular cephalometrics with an average measurement of 90°. According to Tweed, the inclination of the lower incisors may be corrected by referring to the concepts of facial balance and occlusal stability [16].

Data analysis was done using the non-parametric Wilcoxon test to determine the difference in the variables I-SN, nasolabial angle, IMP, and mentolabial angle before and after orthodontic treatment that could be attributed to the presence of some abnormally distributed data. To determine the correlation between the changes in I-SN and IMP angles and in nasolabial and mentolabial angles, the Spearman correlation test was conducted.

To ensure reliability, an inter-operator test using an unpaired the T-test was performed on 30% of the total samples (nine pairs of before and after cephalograms). The results of the unpaired T-test showed that, between the researcher and the supervisor, the tracing and measurement of the cephalograms on the inclination of the upper and lower incisors and the nasolabial and mentolabial angles were not significantly different. The consistency of the researcher in tracing and measuring the I-SN, IMP, nasolabial, and mentolabial angles in the intra-operator test was performed on 10% of the samples (three pairs of before and after cephalograms), using a paired T-test conducted 1 week after the inter-operator test. The results of the paired T-Test confirmed the high reliability of the researcher in tracing and measurement of cephalograms.

The average I-SN angle before treatment (108.73° ± 5.98°) was greater than normal and had an insignificant decrease after orthodontic treatment (3.42°). These results differed from those obtained by Erdinc et al., who found an insignificant increase in the I-SN angles, with a mean angle of I-SN before treatment of 104.21° ± 6.7° and after treatment of 106.03° ± 5.91° [15]. Because the movement of teeth was restricted by fixed orthodontic appliances during treatment, the change in I-SN angles was insignificant. In the results of this treatment, there was a decrease in the average I-SN angle from 108.73° ± 5.98° before treatment to 105.31° ± 7.61° after treatment because of pressure from the wires of the fixed orthodontic appliance. The use of rectangle-shaped wires in fixed orthodontic appliances produces a more controlled movement of the tooth roots compared to that produced by removable orthodontic appliances using round-shaped wires. This causes controlled tipping, which is the palatal movement of the tooth crown with minimal root movement to the labial, causing an insignificant change to the I-SN angle [17]. The inclination of the incisors at the end of a treatment is affected not only by the tooth position and skeletal discrepancy before treatment but also by the variation in crowding present [16].

Generally, the hard tissues of the face are covered by the soft tissues that lie over it; the inclination of the incisors therefore affects the protrusion of the lips. In our study, the average nasolabial angle before treatment was 91.65° ± 9.12°, and that after treatment was 91.73° ± 10.82°. In this case, we observed an insignificant increase in the nasolabial angle of 0.08°. These results were similar to those by Verma, Khan, and Fida, which demonstrated an insignificant increase in the average nasolabial angle after non-extraction orthodontic treatment [10,15,18] Related to lip retrusion, which—even though it was not significant—may have been caused by movement of tooth crowns to the palatal due to retraction of the incisors,.

There was a very weak negative correlation ($r = -0.043$) between the change in I-SN angles and the change in the nasolabial angle, which was not statistically significant ($p = 0.835$), indicating that there was almost no correlation between the two variables. These correlation results were similar to those of Almeida et al., which also demonstrated a weak negative correlation between the I-SN angle and the

nasolabial angle ($r = -0.1626$) with SN −7° as the reference plane in measurement of the inclination of upper incisors. Khan and Fida, however, found a relatively strong negative correlation between the I-SN angle and the nasolabial angle ($r = -0.543$). They asserted that the correlation between the soft tissue and the hard tissue cannot be determined, despite evidence to the contrary [19], showing a tendency of I-SN angles to decrease after treatment, followed by an increase of nasolabial angles, even though the correlation was weak. In patients who had had Class I non-extraction orthodontic treatment, the average I-SN angle decreased, and the average nasolabial angle increased; the correlation was therefore negative because of the abnormally distributed data.

In our study, the average IMP angles before and after treatment were 97.29° ± 6.40° and 99.85° ± 6.70°, respectively. Using the Wilcoxon test, we obtained a significant difference between IMP angles before and after orthodontic treatment, with a significance level of $p = 0.010$. Our results were similar to those of Erdinc et al. and also the study by Khan and Fida, which found a significant increase in IMP angles after non-extraction orthodontic treatment [15,16,19]. The increase in IMP angles may be caused by the tipping movement of the lower incisors to the labial due to orthodontic treatment. The results of this study showed that the average mentolabial angle before orthodontic treatment was normal (123.90° ± 14.39°) and significantly increased after treatment (to 128.65° ± 12.23°). These results were different from those of Verma et al. and Kocadereli, who found protraction of the lower lips along with a large decrease in the mentolabial angle. Verma et al. and Kocadereli had subjects aged under 18 years, at which age the subjects were still influenced by growth factors. According to Khan and Fida, the lower lip has a strong correlation with the retraction of the upper and lower incisors [19]. This statement supported the results of our study, where the mentolabial angle may have been influenced by the retraction of the upper incisors.

Changes in IMP and in mentolabial angle were very weakly negatively correlated ($r = -0.021$), and the change was insignificant ($p = 0.920$), indicating the almost complete absence of a correlation between the two variables. These results corroborated those in the study by Khan and Fida, demonstrating a weak correlation between IMP and mentolabial angles ($r = -0.116$) [19]. This suggests that, with an increase in IMP, there is also a tendency for an increase in mentolabial angle, even though the correlation is very weak. Both the average IMP angle and mentolabial angle increased after Class I non-extraction orthodontic treatment, demonstrating a negative correlation due to the abnormal distribution of data. Verma et al. stated that a change in the position of teeth is not necessarily followed by a change in the soft tissue profile. The variation of soft tissue response of an individual toward an orthodontic treatment may be affected by many variables—such as the morphology of the lips, type of treatment, extraction or non-extraction case, the choice of teeth to be extracted, and the age and gender of the patient [14]. Apart from influences from orthodontic treatment, changes in facial profile are also related to variables such as stretching of the lips before treatment, variation in the structure of the lips, and amount of retraction of the incisors [15].

Even though the hard tissues are covered by the soft tissues above them, the response of the soft tissues in each individual toward orthodontic treatment may vary. Therefore, an understanding of the factors that may influence the soft tissue response toward orthodontic treatment is needed for a correct diagnosis and formulation of a treatment plan so as to achieve the aims of the orthodontic treatment, which are good esthetics, function, and stability.

5. Conclusion

Before and after Class I malocclusion non-extraction orthodontic treatment, there were no statistically significant differences between the average I-SN and nasolabial angles, but the average IMP and mentolabial angles were statistically significantly different. A very weak, negative, and insignificant correlation was observed between changes in the I-SN angles and changes in the nasolabial angles due to the decrease in the average of I-SN angles followed by an increase in the average nasolabial angles, and between changes in the IMP angles and changes in the mentolabial angles due to the increase in the average of IMP angles followed by an increase in the average of mentolabial angles.

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