

## Soft Tissue Changes after Orthodontic Anterior Retraction in Adult Indonesian Patients with the Dolichofacial Type

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### Abstract

In recent years, there has been a noticeable increase in the awareness and interest in facial aesthetics. A pleasant profile is one of the main goals of orthodontic treatment. Orthodontic treatment with anterior retraction changes the soft tissues, particularly those relating to the lips and chin. In addition, soft tissue changes are also influenced by other factors, such as variations in the lip tonus, thickness, and length, sex, treatment mechanism, and racial ethnic background. **Purpose:** This study aimed to evaluate the soft tissue changes in the lips and chin after orthodontic treatment with anterior tooth retraction in the adult dolichofacial type. The subjects consisted of 34 patients, aged 17–35 years old, with the dolichofacial type (facial axis  $< 90^\circ$ ), class I and class II malocclusion, and retraction of the anterior teeth ( $\geq 1$  mm). The pre- and post-treatment cephalograms of the 34 patients were used to determine the pterygomaxillary line and for the Steiner analysis. The t-test, Pearson's correlation, and multiple liner regression were used to analyze the pre- and post-treatment cephalograms. This study showed the differences in the soft tissue before and after orthodontic treatment with anterior tooth retraction in the dolichofacial type. Maxillary anterior tooth retraction had a significant effect on the upper lip thickness, upper lip position, and lower lip position changes, while mandibular anterior tooth retraction had a significant effect on the lower lip thickness changes. Anterior tooth retraction had a strong correlation with the changes in the lip thickness and lip positions in the dolichofacial type patients

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### Introduction

In recent years, there has been a noticeable increase in the awareness of and interest in facial aesthetics. Aesthetic benefits are among the main goals of orthodontic treatment, and clinicians are often asked about possible changes in the profile caused by a certain treatment plan.<sup>1</sup> There is general agreement that orthodontic treatment may influence the soft tissue profile, but there is still disagreement about the amount of soft tissue changes following anterior tooth retraction. Some studies have shown a definite correlation between incisor

movement and soft tissue changes, while other research has shown that the profile improvements in patients treated with four premolar extractions varied greatly.

Less emphasis has been given to the description and comparison of the soft tissue aspects of the different morphological classes. Blanchette *et al.* (cit. Lai *et al.*, 2000) showed that the growth changes in the thickness and length of the lips varied among the different facial types. In their study, the people with long vertical facial patterns tended to have a thicker soft tissue drape and longer vertical height of the upper and lower lips, almost compensating for their skeletal pattern.<sup>2</sup> The provision of such information may assist in planning orthodontic cases according to these characteristic, while helping to establish a specific soft tissue prognosis for each pattern.<sup>2-5</sup>

The present study was undertaken to determine the soft tissue changes, particularly those relating to the lips and chin, in orthodontic anterior tooth retractions in Indonesian adult patients with the dolichofacial type.

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## Materials and methods

### Study sample

This was a cross sectional study of samples selected randomly from the orthodontic clinic at the Universitas Indonesia dental hospital. The data were obtained from the pre- and post-treatment lateral film-based cephalometric radiographs of 34 deuteromalayid race Indonesian patients with the dolichofacial type. The minimum patient age was 17 years old and the maximum age was 35 years old (9 males and 25 females). Those patients with anterior tooth retraction ( $\geq 1$  mm), malocclusion skeletal classes I and II, and high quality pre- and post-treatment lateral cephalometric radiographs taken with the same cephalostat were included in this study. None of the patients had congenitally missing teeth (except third molars), a history of or current orthodontic treatment and functional appliances, or undergone surgical procedures between the two radiographs.

### Cephalometric analysis

All of the pre- and post-treatment cephalograms were traced by two examiners, and they were digitized using Digora for Windows 2.6 software. The measurements to both the hard and soft tissue landmarks were made with reference to the pterygomaxillary (PM) line for the subsequent evaluation of the horizontal soft tissue thickness changes. The PM line ran through Se and Ptm and the horizontal line was constructed perpendicular to the PM line through Se. The lip position was evaluate by measuring the tip of the lips to the line ran between the middle of Steiner's line (the S shaped curvature between the tip of the nose and the subnasale) to the point of the soft tissue pogonion. Gonzales-Ulloa's profile line was a vertical line dropped from the soft tissue of the nasion, perpendicular to the Frankfort horizontal plane for the evaluation of the chin position. The cephalometric landmarks, tissue thicknesses, lip lengths, and lip and chin position measurements used in this study are listed in Table 1 and illustrated in Figures 1 and 2.

### Reliability

All of the cephalometric radiographs were retraced and redigitized after an interval of 1 week by 2 examiners in order to calculate the method error. Intraclass correlation coefficients (ICC) were used for detecting the intra-rater

agreement. No major differences were found since all of the ICCs were greater than or equal to 0.758. Thus, the method error was considered to be negligible.

### Statistical analysis of the data

Pearson's correlation coefficients were calculated to assess the association between the hard and soft tissue measurements. A significance level of  $P < 0.05$  was selected. A multiple regression analysis was used to determine the best combination of variables that predicted the lip and chin changes during the orthodontic treatments at a significance level of  $P < 0.05$ .

## Results

The means and standard deviations of the pre- and post-treatment measurements and the changes between them are shown in Table 2. The Pearson correlation test (Table 3) showed significant positive correlations between the changes in the maxillary anterior retraction and the changes in the upper lip thickness ( $r = 0.62$ ,  $p < 0.005$ ), upper lip position ( $r = 0.53$ ,  $p < 0.005$ ), and lower lip position ( $r = 0.52$ ,  $p < 0.005$ ), as well as between the mandibular anterior retraction and the changes in the lower lip thickness ( $r = 0.51$ ,  $p < 0.005$ ) and lower lip position ( $r = 0.43$ ,  $p < 0.005$ ), and between the maxillary and mandibular anterior retraction and the changes in the lower lip position ( $r = 0.52$ ,  $p < 0.005$  and  $r = 0.43$ ,  $p < 0.005$ , respectively).

The stepwise multiple regression showed that a 1 mm maxillary and mandibular anterior retraction would produce a 0.54 mm decrease in the upper lip thickness, a 0.68 mm decrease in the lower lip thickness, a 0.46 mm retraction of the upper lip position, and a 0.33 mm retraction of the lower lip position.

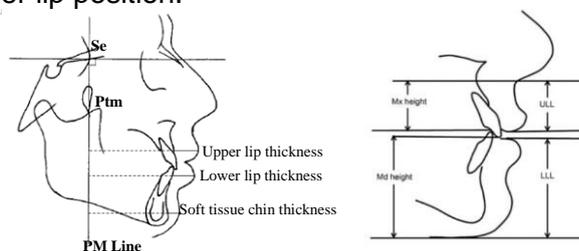


Figure 1. A. Soft tissue thickness  
PM (Pterygomaxillary),  
Se (Sphenoethmoidale),  
Ptm (Pterygomaxillary fissure)

B. Upper and lower lips length

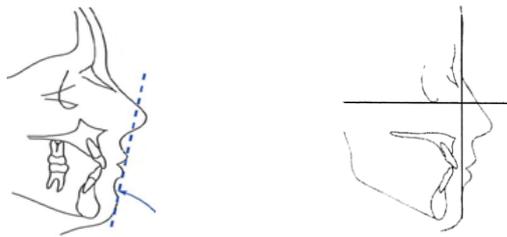


Figure 2. A. Steiner's line

B. Gonzales-Ulloa's profile line

Landmark/Measurement	Definition
Upper lip length	Distance between the subnasale and stomion superius
Lower lip length	Distance between the stomion inferior and the soft tissue of the menton
Upper lip thickness	Distance between the vermilion point of the upper lip and the inner aspect of the lip, drawn perpendicular to the pterygomaxillary (PM) line
Lower lip thickness	Distance between the vermilion point of the lower lip and inner aspect of the lip, drawn perpendicular to the PM line
Soft tissue chin thickness	Distance between the hard tissue of the pogonion and the point of intersection with the outline of the soft tissue of the chin, drawn perpendicular to the PM line
Upper lip position	Change in the upper lip position to Steiner's line
Lower lip position	Change in the lower lip position to Steiner's line
Chin position	Dropping a vertical line through the soft tissue of the glabella line perpendicular to the horizontal line of the Frankfort horizontal plane

**Table 1.** The cephalometric landmarks and tissue measurements used in this study.

	Maxillary anterior retraction		Mandibular anterior retraction	
	r	P	r	P
Upper lip length	-0.07	0.69	0.08	0.64
Lower lip length	-0.05	0.75	-0.08	0.62
Upper lip thickness	0.62	0.00**	0.14	0.42
Lower lip thickness	0.15	0.37	0.51	0.00**

Soft tissue chin thickness	0.00	0.99	0.08	0.64
Upper lip position	0.53	0.00**	0.16	0.35
Lower lip position	0.52	0.00**	0.43	0.01**
Chin position	0.03	0.82	0.24	0.16

**Table 3.** Correlations between the hard tissue and soft tissue changes.

\* Correlation significant at the 0.05 level.

\*\* Correlation significant at the 0.01 level.

## Discussion

Research regarding the changes in the soft tissue after orthodontic treatment with anterior tooth retraction has been widely conducted. Most researchers have reported that there is a correlation between the soft-tissue changes and anterior tooth retraction, especially the soft tissues of the lips and chin. This study used 34 lateral cephalographs of patients with the dolichofacial type (facial axis < 90°), aged 17–35 years old, with maxillary and mandibular retraction (≥ 1 mm), with or without tooth extractions, and class I and II malocclusions.

The variables studied showed the soft tissue changes after orthodontic treatment with anterior tooth retraction in the dolichofacial type. The results showed that there were significant changes in the soft tissues, including the lip thickness and lip position; however, there were no significant changes in the lip length, chin thickness, and chin position. These soft tissue changes correlated with the results of Jamilian *et al.*'s study, which stated that orthodontic treatment with anterior tooth retraction resulted in soft tissue changes, especially in the lower third of the face, specifically, the lips, nasolabial angle, labiomental angle, and area around the chin.<sup>6</sup>

The average anterior tooth retraction in this study was 3.06 mm in the maxilla and 2.57 mm in the mandible. The magnitude of the retraction depends on the severity of the crowding, with or without tooth extraction. In addition, the dolichofacial type is known to exhibit a posterior shift to mesial or anchorage loss due weak facial musculature when compared to the brachyfacial type.<sup>7</sup>

Significant soft tissue changes occurred in the upper lip thickness, lower lip thickness, upper lip position, and lower lip position. The thickness of the lips decreased significantly (p = 0.000): the upper lip thickness decreased by 1.98 mm and the lower lip thickness decreased by 1.73 mm, on average. These results were in accordance with

those of Ramos *et al.*, who stated that the average upper lip thickness decreased after orthodontic treatment with anterior tooth retraction. He reported that the upper lip thickness decreased from 0.7 – 0.8 mm with premolar tooth extraction.<sup>8</sup> Lamastra (cit. Ramos *et al.*, 2005) reported a slightly greater decrease in the lip thickness (1 mm) when the labial groove (A') was retracted 1 mm, and Hershey (cit. Ramos *et al.*, 2005) described a 0.71 mm reduction with 1 mm of retraction. However, Tallas *et al.*, Chiavini, and Ricketts (cit. Ramos *et al.*, 2005) reported increases in the upper lip thickness due to the retraction of the maxillary incisors.<sup>8</sup> These differences were probably related to the age, sex, race, and method of treatment.<sup>6,8-10</sup>

The lip positions in this study were significantly retracted ( $p = 0.000$ ), with the upper lip retracted by 1.60 mm and the lower lip retracted by 1.66 mm, on average. Khurshid *et al.*, Sukhia *et al.*, Hayashida *et al.*, and Burrow reported that anterior tooth retraction causes lip retraction, and that the changes that occur are comparable to the amount of retraction.<sup>11-14</sup> The greater the anterior tooth retraction performed, the greater the retraction of the lips. According to Tallas *et al.*, the withdrawal of the upper lip position due to premolar tooth extraction only explained about 48.5% of the results. For the rest, the withdrawal of the upper lip position was associated with incisor edge retraction, thinner soft tissue before treatment, a thicker upper lip before treatment, and a greater amount of vertical nasal growth during treatment.<sup>15</sup> Hayashida *et al.* reported that overjet reduction and the initial upper lip thickness could explain 15% of the variations in the upper lip position, while the rest were affected by ethnicity, sex, and the malocclusion type.<sup>8,13</sup>

The lip structure also affects the amount of anterior tooth retraction. Reportedly, a thinner lip structure has a significant correlation with anterior tooth retraction. According to Holdaway, a retraction of the maxillary lip does not follow tooth retraction until the factor of lip strain has been eliminated. He also reported that 1 mm of lip strain is normal for individuals with an orthognathic profile.<sup>9,8,11,13,16-18</sup>

The soft tissue changes were not significant with regard to the lip length, chin thickness, and chin position, which translates to clinical changes. The results showed that the length of the lip increased for both the upper and lower

lips, and that the lower lip length increased insignificantly more than the upper lip length. In their study, Tallas *et al.* reported that the lower lip length increased significantly when compared to the upper lip length with anterior tooth retraction.<sup>15</sup> Assuncao *et al.* (cit. Amirabadi *et al.*, 2014) reported that the upper lip length did not exhibit any significant changes with regard to anterior tooth retraction in adult patients.<sup>18</sup> The increased lower lip length may have been caused by several factors, such as a longer lower lip prior to treatment, greater anterior tooth retraction in the mandible, more relaxed lip muscles, and an increased lower face length due to orthodontic treatment.<sup>15,18</sup> The increasing lower lip length after orthodontic treatment with anterior tooth retraction will decrease the interlabial gap, increasing the lower face length. Attention should be paid to this factor, especially in dolichofacial patients with long and narrow facial characteristics.<sup>2,4,5,9,17</sup>

This study showed that the soft tissue thickness of the chin decreased and the chin position retreated insignificantly. In their research, Hosseinzadeh-nik *et al.* stated that the chin's soft tissue thickness was significantly decreased after orthodontic treatment with or without tooth extraction.<sup>19</sup> They stated that the B point and Pog retreated due to orthodontic treatment with or without tooth extraction. This is different from the results reported by Premkumar, who stated that the thickness of the chin's soft tissue increased after orthodontic treatment. The difference between the results of these studies is probably associated with the orthodontic treatment system and technique administered.<sup>16</sup>

When using the Pearson correlation test, the results of this study showed that there was a significant correlation between maxillary anterior retraction and changes in the upper lip thickness and upper lip position, and between mandibular anterior retraction and changes in the lower lip thickness. Both maxillary and mandibular anterior retraction exhibited significant correlations with the lower lip position changes. Lai *et al.* stated that there was a strong correlation between the soft tissue response to tooth movement. Some researchers also found that there was a strong correlation between anterior tooth retraction and lip position changes.<sup>2</sup> Kusnoto and Kusnoto reported that there was a strong correlation between mandibular incisor tooth retraction and changes in the upper and lower lip positions.<sup>2,10,20</sup>

The soft tissue changes showed an insignificant correlation between maxillary anterior

tooth retraction and lower lip thickness changes, and between mandibular anterior tooth retraction and changes in the upper lip thickness and lip positions. Both maxillary and mandibular anterior tooth retraction showed insignificant correlations with changes in the upper and lower lip lengths and chin thickness and position. Based on the orthodontic literature, the relationships between hard tissues and soft tissues vary greatly; some have strong relationships, but some are independent. The differences were influenced by the soft tissue characteristics, such as the length, thickness, and functional aspects, like soft tissue tonicity.<sup>21</sup>

The results of the multiple linear regression analysis showed that maxillary anterior retraction had a significant effect on the upper lip thickness and position changes and the lower lip position changes. Mandibular anterior tooth retraction had a significant effect on the lower lip thickness changes. This is in accordance with the research done by Leonardi *et al.*, Bravo, and Tadic *et al.*, who stated that anterior tooth retraction had an effect on the changes in the soft tissues of the lips.<sup>9,22,23</sup> It is known that in cases of bimaxillary protrusion, the lower lip most commonly makes contact between the upper incisor and lower incisor, so the lower lip position changes are not only affected by mandibular anterior retraction, but also by maxillary anterior retraction.<sup>11</sup> However, maxillary anterior retraction had no significant effect on the lower lip thickness changes, and mandibular anterior retraction had no significant effect on the upper lip thickness, upper lip position, and lower lip position.

The amount of soft tissue changes after orthodontic treatment with anterior tooth retraction on the dolichofacial face type can be determined from multiple linear regression equations. The multiple linear regression results showed that with a maxillary anterior tooth retraction value of 1 mm and mandibular anterior tooth retraction value of 1 mm, the upper lip thickness decreased by 0.54 mm, the lower lip thickness decreased by 0.68 mm, the upper lip retracted by 0.46 mm, and the lower lip retracted by 0.33 mm. Kusnoto and Kusnoto in Indonesia showed that with a mandibular incisor retraction of 1 mm, the upper lip retracted by 0.4 mm and the lower lip retracted by 0.6 mm. The results of this study (with a mandibular incisor retraction of 1 mm, there were changes in the upper lip position) were insignificantly different from the research conducted by Kusnoto and Kusnoto, but

slightly different from the changes in the lower lip position. However, the study by Kusnoto and Kusnoto showed that the changes in the lower lip position were slightly bigger.<sup>20</sup> In Japan, Hayashida *et al.* reported that a maxillary anterior tooth retraction of 1 mm will cause an upper lip retraction of 0.45 mm and a lower lip retraction of 0.38 mm. Some other researchers also had different ratios associated with a 1 mm anterior tooth retraction.<sup>13</sup> These differences were related to the age, sex, lip morphology, treatment method, with or without extraction, tonicity and thickness of the soft tissue, lip length, and racial background.<sup>6,9,10</sup>

## Conclusions

Anterior tooth retraction can cause soft tissue changes in the lips and thinning in the dolichofacial type. In addition, significant changes occurred in the lip thickness and lip position. Moreover, maxillary anterior retraction showed a significant correlation with decreases in the upper lip thickness and upper lip retraction. In addition, mandibular anterior retraction showed a significant correlation with a lower lip thickness decrease. Both upper and lower tooth retraction showed a significant correlation with lower lip retraction. Furthermore, the results also showed that maxillary anterior retraction had significant effects on the upper lip thickness and upper and lower lip positions. Overall, the retraction of the mandible significantly affected the thickness of the lower lips.

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Variables	Pre treatment		Post Treatment		Changes				
	Mean	SD	Mean	SD	Mean	SD	Min	Max	P
Upper lip length	30.11	4.40	30.62	3.93	-0,50	3.12	-4.25	-1.26	0.34
Lower lip length	52.31	5.95	53.08	4.93	-0.77	4.27	-0.62	5.05	0.30
Upper lip thickness	89.86	5.64	87.88	5.30	1.98	1.65	-0.76	2.92	0.00*
Lower lip thickness	89.49	7.12	87.76	6.79	1.72	1.30	-1.34	2.82	0.00*
Soft tissue chin thickness	80.82	8.59	80.18	7.84	0.63	5.20	-0.04	0.56	0.48
Upper lip position	4.18	1.16	2.58	1.14	1.60	1.12	2.02	0.65	0.00*
Lower lip position	3.94	1.15	2.28	1.36	1.65	1.19	1.78	1.82	0.00*
Chin position	3.73	2.13	3.72	2.02	0.01	2.52	0.00	-0.63	0.97

**Table 2.** The means and standard deviations (SDs) of the horizontal and vertical pre- and post-treatment measurements and the treatment changes.