

# Enhanced Soft Tissue Adaptation Following Incisor Retraction in Orthodontic Treatment: A Strong Correlation

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## ABSTRACT

**Objective:** This study aims to evaluate the correlation between soft tissue adaptation and the retraction of incisors in Class II Division 1 malocclusion patients treated with fixed appliances and premolar extractions. **Materials and Methods:** Thirty-one patients underwent orthodontic treatment with fixed edgewise mechanics and four premolar extractions. Cephalometric analyses were conducted to assess soft tissue changes relative to incisor movements. The correlation of soft tissue landmarks with horizontal and angular changes of incisors was analyzed using Spearman's correlation coefficient. Statistical significance was set at  $p < 0.05$ . **Results:** Strong positive correlations were observed between the retraction of the maxillary incisor tip (U1-y) and upper lip (Ls-y,  $r = 0.887$ ,  $p < 0.001$ ) and lower lip (Li-y,  $r = 0.765$ ,  $p < 0.001$ ) positions. Point A (A-y) also showed a strong positive correlation with U1-y ( $r = 0.907$ ,  $p < 0.001$ ). No significant correlation was found between nasolabial angle and U1-y. Changes in upper incisor inclination relative to the NA plane were negatively correlated with the nasolabial angle ( $r = -0.474$ ,  $p = 0.007$ ). Mandibular incisor retraction (L1-y) demonstrated significant positive correlations with lower lip (Li-y,  $r = 0.757$ ,  $p < 0.001$ ), upper lip (Ls-y,  $r = 0.810$ ,  $p < 0.001$ ), point B (B-y,  $r = 0.785$ ,  $p < 0.001$ ), and Pogonion (Pog-y,  $r = 0.749$ ,  $p < 0.001$ ). **Conclusions:** Soft tissue adaptation is closely correlated with the horizontal retraction of both upper and lower incisors. These findings emphasize the importance of evaluating soft tissue responses in orthodontic treatment planning to optimize aesthetic outcomes.

**Keywords:** *Soft tissue adaptation, incisor retraction, cephalometric analysis, Class II Division 1, orthodontics*

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## INTRODUCTION

Class II Division 1 malocclusion is characterized by an unbalanced facial profile and often presents with issues such as increased overjet, protruding anterior teeth, and improper bite alignment. These

features can lead to both functional and aesthetic concerns, making orthodontic treatment essential for improving teeth alignment and overall facial appearance. Treatment for Class II malocclusion typically involves various strategies, including the retraction of anterior teeth,

which is crucial for achieving optimal occlusion and facial harmony<sup>1,2</sup>. However, retracting the upper and lower incisors can significantly impact the surrounding soft tissues, particularly the lips and other perioral structures, affecting their position and overall appearance. Understanding how the retraction of anterior teeth during orthodontic treatment influences soft tissue adaptation is important for achieving not only functional improvements but also aesthetic outcomes that align with the patient's facial features<sup>3,4,5</sup>. Following incisor retraction, soft tissue changes such as repositioning of the lips and alterations in the nasolabial angle are often observed. These changes can impact on the patient's smile, profile, and overall facial aesthetics<sup>6,7,8,9</sup>.

## MATERIALS AND METHODS

### Study design and subjects

This descriptive follow-up study included patients diagnosed with Angle Class II Division 1 malocclusion. All participants underwent treatment using fixed edgewise mechanics with the extraction of four premolars at the School of Dentistry and Hanoi Central Odonto-Stomatology Hospital between November 2020 and June 2021. Based on the severity of crowding and the required retraction of maxillary anterior teeth, participants were categorized into two groups: Group 1 (n = 19) received maximum anchorage using micro-implants, while Group 2 (n = 12) underwent conventional anchorage with devices such as transpalatal arches, Nance appliances, or second molar bands.

#### *Inclusion criteria*

- Patients of Vietnamese descent.
- Permanent dentition with pre-treatment Class II Division 1

malocclusion as per Angle's classification:

- + Class II molar and canine relationship.
- + Pre-treatment overjet exceeding 3 mm.
  - Treatment plan involving fixed edgewise mechanics and four premolar extractions.
  - Availability of high-quality pre-treatment (T1) and post-treatment (T2) cephalograms.
  - Patients provided informed consent for participation.

#### *Exclusion criteria*

- The presence of congenital malformations.
- Tooth agenesis or loss (except third molars).
- Dentofacial trauma.
- Requirement for orthognathic surgery.
- Failure to meet any inclusion criteria.

### Procedures

Cephalometric radiographs were captured using Orthoralix Cephalometric Radiographs 9200 (Care Stream, USA) at Hanoi Central Odonto-Stomatology Hospital and Orthophos XG5 (Sirona, Germany) at the School of Dentistry. Landmarks and reference lines on the radiographs were manually traced on matte acetate tracing papers (Ormco, USA) by orthodontists using a 0.5mm mechanical pencil. Angular and linear cephalometric measurements were performed using a cephalometric orthodontic protractor (Ormco, USA).

### Data analysis

Statistical analyses included paired-sample t-tests and Wilcoxon signed rank tests to evaluate changes over time, and Mann-Whitney U tests to compare median values between the micro-implant and

conventional anchorage groups. Analyses were conducted using SPSS 20.0 (IBM, USA). Spearman’s correlation coefficient

was used to evaluate the relationship between soft tissue adaptation and incisor retraction.

## RESULTS

We noticed the good correlations between the horizontal changes of upper and lower lips position and that of the maxillary incisor tip position. There were also significantly positive correlations between the horizontal adjustment of point A and that of maxillary incisor tip position.

No correlation between the alteration in nasolabial angle and the horizontal change of maxillary incisor tip position.

**Table 1.** *The correlation of the adaptation of soft tissue and the retraction of upper incisors with the reference plane y*

Variable 1 (T2-1)	Variable 2 (T2-1)	Correlation coefficient (r)	p
Ls-y (mm)	U1-y	0.887	0.000
Ls-SnPog’ (mm)	U1-y	0.585	0.001
Li-y (mm)	U1-y	0.765	0.000
A-y (mm)	U1-y	0.907	0.000
Ps-Sn-Ls ( <sup>0</sup> )	U1-y	-0.133	0.476

There were significantly negative correlations between the change in the nasolabial angle and that of the upper incisor inclination related to NA and SN planes.

The results shown in Table 3.5 also indicated that the change in upper incisor inclination related to NA had a significantly positive correlation with the horizontal change in lower lip position.

**Table 2.** *The correlation of the adaptation of soft tissue and the changes of upper incisors’ inclination*

Variable 1 (T2-1)	U1-NA (T2-1)		U1-SN (T2-1)	
	Correlation coefficient (r)	p	Correlation coefficient (r)	p
Ls-y (mm)	0.246	0.183	0.179	0.335
Ls-SnPog’ (mm)	0.255	0.166	0.249	0.177
Li-y (mm)	0.381	0.034	0.209	0.258
A-y (mm)	0.191	0.304	0.140	0.451
Pn-Sn-Ls ( <sup>0</sup> )	-0.474	0.007	-0.414	0.021

The adaptation of soft tissue, except for the mentolabial angle, had significantly positive correlations with the horizontal change of mandibular incisor tip position. There were significant positive correlations between the horizontal change in the point B and Pogonion positions and those of mandibular incisor tip position.

**Table 3.** The correlation of soft tissue adaptation and the retraction of lower incisor with the reference plane y

Variable 1 (T2-1)	Variable 2 (T2-1)	Correlation coefficient (r)	p
Li-y (mm)	L1-y	0.757	0.000
Li-SnPog' (mm)	L1-y	0.559	0.001
Ls-y (mm)	L1-y	0.810	0.000
B-y (mm)	L1-y	0.785	0.000
Pog-y (mm)	L1-y	0.749	0.000

There was no correlation between the adjustments of lower incisor inclination and the changes of several hard and soft tissue variables evaluated.

**Table 4.** The correlation of soft tissue adaptation and the changes of lower incisors' inclination

Variable 1 (T2-1)	L1-NB (T2-1)		L1-MP (T2-1)	
	Correlation coefficient (r)	p	Correlation coefficient (r)	p
Ls-y (mm)	0.244*	0.187	0.306	0.094
Li-y (mm)	0.204	0.272	0.250	0.174
Pog-y (mm)	0.215*	0.245	0.280	0.127
B-y (mm)	0.190	0.305	0.236	0.202
Pn-Sn-Ls <sup>(0)</sup>	-0.164	0.378	-0.140	0.451
Li-B'-Pog' <sup>(0)</sup>	-0.149	0.424	-0.016	0.930

## DISCUSSIONS

The results of our study indicate that soft tissue adaptation is primarily influenced by the horizontal retraction of the incisors. Specifically, the retraction of the upper lip and lower lip demonstrated strong correlations with the movement of the maxillary and mandibular incisors, respectively. This suggests that lip position changes are closely linked to incisor movements. However, the nasolabial angle showed a weak correlation with incisor retraction, implying that changes in this angle are less dependent on dental movements and

are more influenced by individual anatomical structures and muscle dynamics.

Our findings further reveal that the retraction of the upper and lower lips correlates closely with the retrusion of the upper and lower incisors. These results are consistent with those of Hayashida and Ramos<sup>10,11</sup>, who observed similar patterns in their studies. However, contrasting with our findings, Yasutomi's research on a Japanese cohort reported that only the upper lip had the strongest horizontal correlation with the position of the upper incisors<sup>12</sup>.

When analyzing the correlation between incisor movement and nasolabial angle changes, our study shows no significant

relationship. These findings support Fitzgerald's conclusion that soft tissue changes in the nasolabial region occur independently of underlying hard tissue movements<sup>13</sup>. Ramos's findings also align with this view, as he found no strong correlation between nasolabial angle changes and incisor retraction<sup>11</sup>.

These results contribute to the growing body of evidence suggesting that soft tissue responses to orthodontic treatments exhibit considerable variability across individuals and ethnic groups<sup>14,15,16,17</sup>. This highlights the importance of considering individual anatomical and physiological factors when evaluating soft tissue changes in response to dental movements.

Future research should focus on long-term studies with larger and more diverse patient populations, employing advanced imaging technologies to deepen the understanding of soft tissue dynamics. Such investigations will further refine clinical approaches and improve predictive models for soft tissue adaptation.

## CONCLUSIONS

In conclusion, understanding the strong interplay between incisor retraction and soft tissue adaptation is vital for achieving optimal orthodontic outcomes. A comprehensive treatment approach that integrates both hard and soft tissue considerations ensures not only functional correction but also improved facial harmony, ultimately enhancing the overall success and patient satisfaction in orthodontic care. Orthodontic treatment involving incisor retraction leads to significant soft tissue changes, particularly in the upper and lower lips. The strong correlations observed highlight the importance of incorporating soft tissue analysis into treatment planning to

achieve optimal aesthetic outcomes. Future research should explore the long-term stability of these changes and their implications for diverse patient populations.

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