



# Evaluation of the Effects of Various Levels of Maxillary Incisor Protrusion on Upper Lip

## Farklı Üst Kesici Diş Protrüzyon Miktarlarının Üst Dudak Üzerindeki Etkilerinin Değerlendirilmesi

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### Abstract

**Introduction:** This study aimed to evaluate the effect of upper central incisors on the upper lip after fixed orthodontic treatment.

**Materials and Methods:** In this retrospective study, 30 individuals aged between 202 and 278 months whose lateral cephalometric radiographs were evaluated at the beginning and end of treatment were included. The study was divided into two groups: Group A, in which the upper incisors protruded by 0–1 mm, and Group B, in which they protruded by 1–3 mm. The soft tissue nasolabial angle, upper lip thickness, and upper lip protrusion values were compared at the beginning and end of treatment in both groups. A Mann-Whitney U test was used to determine the relationship between continuous variables, and Spearman correlation coefficient was used to determine the relationship between these variables.

**Results:** The mean upper incisor protrusion was  $0.49 \pm 0.3$  mm for Group A and  $2.29 \pm 0.56$  mm for Group B. The nasolabial angle was  $-0.57 \pm 1.13^\circ$  in Group A and  $-3.78 \pm 76^\circ$  in Group B. The lip thickness was  $0.18 \pm 0.14$  mm in Group A and  $-0.73 \pm 0.49$  mm in Group B. The upper lip protrusion was  $0.34 \pm 0.45$  mm for Group A and  $1.48 \pm 0.45$  mm for Group B. There was a statistically significant difference between the groups for all three values ( $p = 0.001$ ).

**Conclusion:** Upper incisor protrusion was used to determine a decrease in nasolabial angle and a decrease in upper lip protrusion. However, when the protrusion amount increased, a decrease in lip thickness was observed.

**Keywords:** Incisor; lip; cephalometry; orthodontics appliance-fixed.

### Giriş

**Amaç:** Bu çalışmada sabit ortodontik tedavi sonrasında pozisyonu değişen üst santral kesici dişlerin üst dudak üzerine etkisinin değerlendirilmesi amaçlanmaktadır.

**Gereç ve Yöntem:** Bu retrospektif çalışmada bireylerin tedavi başı ve sonu lateral sefalometrik radyografilerinin değerlendirildiği yaşları 202 ay ila 278 ay arasında 30 birey dahil edilmiştir. Araştırma üst kesici dişlerin 0-1 mm protrüze olduğu grup A ve 1-3 mm protrüze olduğu grup B olarak iki gruba ayrılmıştır. Her iki grupta tedavi başı ve sonu yumuşak doku nasolabial açısı, üst dudak kalınlığı ve üst dudak protrüzyonu değerleri karşılaştırılmıştır. Elde edilen sürekli değişkenler bakımından grup Mann-Whitney U testi, Kategorik değişkenler arasındaki ilişkiyi belirlemede Spearman korelasyon katsayısı kullanılmıştır.

**Bulgular:** Ortalama üst kesici protrüzyonu grup A için  $0.49 \pm 0.3$  mm; grup B için ise  $2.29 \pm 0.56$  mm olduğu gözlenmiştir. Nasolabial açının grup A'da  $-0.57 \pm 1.13^\circ$ ; grup B'de ise  $-3.78 \pm 76^\circ$  değiştiği tespit edilmiştir. Dudak kalınlığı grup A'da  $0.18 \pm 0.14$  mm; grup B' de ise  $-0.73 \pm 0.49$  olarak belirlenmiştir. Üst dudak protrüzyonu için grup A  $0.34 \pm 0.45$  mm; grup B için ise  $1.48 \pm 0.45$  mm olarak belirlenmiştir. Her üç değer için de gruplar arasında istatistiksel olarak anlamlı farklılık göstermiştir ( $p=0.001$ ).

**Sonuç:** Üst kesici protrüzyonu ile nasolabial açıda azalma ve üst dudak protrüzyonunda azalma belirlenmiştir. Ancak protrüzyonu miktarı arttığında dudak kalınlığında azalma olduğu gözlenmiştir.

**Anahtar Kelimeler:** Kesici; dudak; sefalometri; sabit ortodontik aparey.

### Introduction

Fixed orthodontic treatment planning aims to achieve, in addition to functional occlusion, a smile that satisfies the aesthetic expectations of individuals and an ideal soft tissue profile (1). Therefore, clinical examination and soft tissue cephalometric analysis are important for a good treatment plan. In the early 1900s, Angle emphasized that soft tissue should be considered in fixed orthodontic treatment planning for facial

harmony (1). Changes in soft tissue may be related to lip tension, changes in lip thickness, and the position of incisors (2). Orthodontic treatment can be carried out with or without extraction. Fixed orthodontic treatment, with or without extraction, affects the position of the upper and lower lips and the position and inclination of the incisors. Various planes and measurements have been established to evaluate lip position (3–7).

Steiner (3), Ricketts (4), Burstone (5), Tweed (6), and Riedel (7) stated that nasal and lip length and nasolabial angle are important factors for aesthetics. There is no consensus in the literature on the interaction between hard tissue profile and soft tissue profile (8–13). Cephalometric X-rays are an important tool for determining the position and relationship between dental and skeletal structures. With the standardization of Broadbent's radiography technique in 1931, soft tissue analysis and dentoskeletal relationships became important factors in the decision-making process for diagnosis and treatment planning (14). This study aimed to investigate the possible effect of changing upper incisor positions on upper lips as a result of fixed orthodontic treatment. The alternative (H0) hypothesis of our study is, "There is no difference between the values of nasolabial angle, upper lip protrusion, and lip thickness with different amounts of protruded upper incisors."

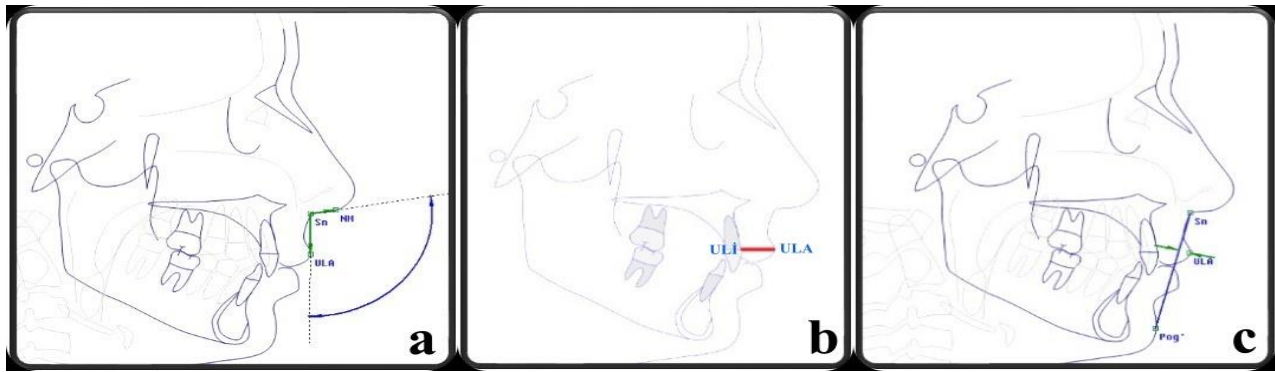
### Materials and Methods

This study was carried out using the lateral cephalometric radiographs of 30 individuals collected from the archive of Van Yüzüncü Yıl University, Faculty of Dentistry, Department of Orthodontics. Informed consent was obtained from the individuals included in the study for the use of the lateral cephalometric radiographs taken for diagnostic purposes. Individuals who had completed all growth/developmental periods, who needed non-extraction orthodontic treatment, who had not been treated for cleft lip and/or palate, and who had not experienced trauma in the

craniofacial region were included in the study. Those who had lateral cephalometric radiographs that were of poor image quality or that showed orthodontic treatment and patients with syndrome were excluded from the study. As part of the treatment process, .018 brackets (Gemini Roth System, 3M Unitek, USA) were applied to 30 individuals who received fixed orthodontic treatment without extraction, and these individuals were treated with the straight wire technique. Leveling and alignment of the teeth were achieved with .012, .014, and .016 nickel titanium (NiTi) arch wires in individuals with nonextraction fixed orthodontic applications. Then, .016 × .016 NiTi and .016 × .022 NiTi arch wires were applied to ensure that the teeth reached the tip and torque values specified in the brackets prospectus. When necessary, maxillomandibular elastics were used. Finally, .016 × .016 and .016 × .022 stainless steel arc wires were used to begin the finishing phase. The incisor positions and soft tissue parameters were evaluated with cephalometric radiographs at the beginning and end of the treatment. Care was taken to ensure that lateral cephalometric radiographs were taken with the Sirona Orthophos XG (Bensheim, Germany) imaging system under standard conditions (73 kVp, 15 mA, and 14.8 s irradiation time). The analysis of cephalometric radiographs was performed by an orthodontist with one year of experience (YT). The cephalometric definitions of the points of the angle and distance values used are shown in Table 1.

**Table 1:** Cephalometric points used in the study

Pogonion (Pog)	The most forward point of the chin
Subnasal (Sn)	The juncture of the nose and upper lip is where the concavity at that region is deepest.
Nasion (N)	The most anterior point of the frontonasal suture
A-point (A)	The deepest point on the maxillary alveolar process's outer contour
U1-NA <sup>0</sup>	Angle between the long axis of the upper central incisor and the NA line
NH	The tip of the nose and the upper part of the upper lip from the centre point of the letter 'S'
ULA	The most anterior point of the upper lip
ULI	The innermost point of the upper lip



**Figure 1.** a) Nasolabial angle, b) Lip thickness, c) Upper lip protrusion

**Table 2:** Descriptive statistics of the individuals included in the study

	Female (%)	Male (%)	n	Age (m)	p	Amount of U1-NA protrusion (mm)
<b>Group A</b>	5 (33.3)	10 (66.7)	15	239.47±23.22	0.650	0.49±0.3
<b>Group B</b>	5 (33.3)	10 (66.7)	15	244.20±22.44		2.29±0.56
<b>Total</b>	10 (33.3)	20 (66.7)	30	241.83±22.56		

Mann Whitney U, \* $p < 0.01$ , n: number of individuals participating

The study participants were divided into two groups according to the amount of protrusion of the incisors. Group A had 0–1 mm protrusions according to the U1-NA line, whereas Group B had 1–3 mm protrusions. Three soft tissue values were measured in each group: two distances and one angle. The comparisons of the cephalometric values at the beginning and end of the treatment are presented in Figure 1. In addition, the angles and distances used in the research are given below.

- Nasolabial angle (°): The angle between the columella, the subnasal, and the most anterior points of the upper lip. (Figure1a)
- Upper lip thickness (mm): The distance between the most prominent protruding part of the upper lip and its parallel inner part. (Figure1b)
- Upper lip protrusion (mm): The length of the perpendicular descending line between the subnasal and pogonion at the most anterior point of the upper lip. (Figure1c)

**Statistical analyses:** Descriptive statistics for the categorical variables from the obtained data are presented as numbers and percentages. For the continuous variables, the descriptive statistics are given as mean, standard deviation, standard error,

minimum, and maximum values. Group medians for the continuous variables were compared using the Mann–Whitney U test. Spearman’s rho test was employed to determine the correlations between these variables. The data were analyzed using IBM SPSS (ver. 20).

**Ethical consent:** After providing a detailed description of the study, every participant signed an informed consent form prepared according to the Declaration of Helsinki. The research was started after receiving the ethics committee’s (2021/12-21) approval from Van Yüzüncü Yıl University Non-interventional Research Ethics Committee. The descriptive data of the individuals included in the study in terms of age, gender, and protrusion amounts of the upper incisors are presented in Table 2. The research groups consisted of 10 females and 20 males: 5 females (33.3%) and 10 (66.7%) males each for Groups A and B. According to the groups, the mean age was  $239.47 \pm 23.22$  months (206–276 months) for Group A and  $244.20 \pm 22.44$  months (202–278 months) for Group B. There was no statistical difference between the groups in terms of age ( $p = 0.650$ ). The mean upper incisor protrusion was  $0.49 \pm 0.3$

**Table 3:** Comparisons for continuous variables in groups

	Groups	Mean±SD	Min	Max	p
<b>Nasolabial Angle</b>	Group A	- 0.57±1.13°	- 4.00	1.00	0.001*
	Group B	- 3.78±0.76°	- 5.00	- 3.00	
<b>Lip Thickness (mm)</b>	Group A	0.18±0.14	-.10	.37	0.001*
	Group B	- 0.73±0.49	-1.98	-.20	
<b>Upper Lip Protrusion (mm)</b>	Group A	0.34±0.45	-.10	.60	0.001*
	Group B	1.48±0.45	.70	2.20	

Mann Whitney U, \* $p=0,05$ , **SD**: Standart deviation **Min**: Minimum, **Max**: Maximum

**Table 4:** Correlation of groups with continuous variables

	Incisor Position	
	Group A	Group B
Nasolabial Angle°	-.545*	-.529*
Lip Thickness (mm)	.597*	-.737**
Upper Lip Protrusion (mm)	.855**	.731**

Spearman rho, \*0.05, \*\*:0.01

mm for Group A and  $2.29 \pm 0.56$  mm for Group B. The nasolabial angle was  $-0.57 \pm 1.13^\circ$  for Group A and  $-3.78 \pm 0.76^\circ$  for Group B. In terms of upper lip protrusion, the measurement for Group A was  $0.34 \pm 0.45$  mm and  $1.48 \pm 0.45$  mm for Group B. Lip thickness was 0.18 mm for Group A and -0.73 mm for Group B. For each of the three values, a statistically significant difference between the groups was observed (Table 3). The correlation of incisor position with all three values in both groups significantly varied within each group (Table 4). However, the statistical difference in lip thickness increase for Group A had a 0.05 confidence interval, whereas the decrease in lip thickness for Group B was within the 0.01 confidence interval.

## Discussion

Changes that may occur in the upper lip with changes in the position of the upper incisors in the alveolar bone are difficult to predict with orthodontic treatment (15–17). According to the findings of our study, the changes in nasolabial angle, upper lip thickness, and upper lip

protrusion values between Group A and Group B were statistically significant ( $p = 0.001$ ). Although a decrease in nasolabial angle and a decrease in upper lip protrusion with the protrusion of the upper incisor were determined, a decrease in lip thickness was observed with an increase in the amount of protrusion of the upper incisors. Hence, the  $H_0$  hypothesis was rejected. There is no consensus in studies examining the changes that may occur in the upper lip with changes in the position of the incisors in terms of gender. In addition to the studies indicating that gender is effective in the changes occurring in the upper lip (18,19), there are also studies indicating that there is a difference, although not statistically significant (20–22). In one study, it was observed that the gender factor was not evaluated at all (23). However, Buschang et al. (24) stated that the gender factor was not effective in their study, in which they examined the changes occurring in the upper lip with changes in the incisor position with orthodontic treatment. In our study, although there were 5 females and 10 males in the groups, the genders were distributed at the same rate in

both groups. Changes in the lips due to the movement of the incisors in the sagittal direction have attracted the attention of many researchers. Although some studies have stated that a certain rate of retrusion occurs in the upper lip with the retraction of the incisors with extraction treatments (25,26), other studies have found no changes (27,28). This disparity has led some researchers to emphasize that the upper incisors may be proclined despite tooth extraction (7,29). However, in studies conducted with individuals treated without extraction, we encountered different findings (15,16,25). These varied results may be due to factors such as different mechanics, crowding rates, types of malocclusions, and developmental periods of individuals. As a result, groups were formed according to the amount of change in the upper incisor position with the NA (Nasion-A point) line of individuals who completed the growth and development period, who were treated without extraction, and who were treated with the same fixed mechanics to minimize the factors that may have affected the results in our research. Cephalometric radiographs are usually chosen as an objective evaluation technique in soft tissue examinations (30). However, three-dimensional imaging techniques have become increasingly popular (16). Although three-dimensional imaging techniques are becoming common nowadays in areas like orthognathic planning, they also have drawbacks, such as high costs and extra radiation (30). Lateral cephalometric radiographs were preferred in our study because they are used in routine orthodontic diagnostic tools and do not require additional costs and time. In our study, care was taken to ensure that the head was in the resting position and that the lips were in their natural position to obtain the actual positions of the soft tissues. The patients were informed about this during the taking of the radiographs. The nasolabial angle is affected by the upper lip angle, the position of the upper incisor, and the thickness of the upper lip (14,15,16). Considering that changes in the position of the incisors may cause alterations in the upper lip, we evaluated changes in the nasolabial angle, lip thickness, and lip protrusion distances in our study. Dogan et al. (17) examined the pre-treatment cephalometric films of 30 individuals evaluated in three groups based on the angle (U1-SN) of the upper incisor axis in relation to the sella-nasion plane. They reported that changes in the upper incisor angle affect midface values, such as the nasolabial angle, upper lip angle, and upper lip thickness. Au et al. (16)

placed wax of increasing thickness (+2, +4, and +6 mm) on the incisors of 20 individuals and simulated soft tissue. Induced lip changes were recorded using three-dimensional stereophotogrammetry. They found that the advancement of the maxillary incisor led to significant changes in the upper lip on three planes. Rongo et al. (15) compared soft tissue changes in 46 individuals, 23 with extraction fixed orthodontic treatment and 23 without extraction fixed orthodontic treatment, on three-dimensional stereophotogrammetric images. They emphasized that the nasolabial angle increased significantly in individuals with fixed orthodontic treatment with extraction, whereas the nasolabial angle decreased in individuals with fixed orthodontic treatment without extraction. In our study, we found a decrease in the nasolabial angle and an increase in upper lip protrusion with upper incisor protrusion. We found that the lip thickness was reduced in Group B as the protrusion quantity increased, which may be due to the soft tissue structure of the muscles and upper lip and the pressure placed on the perioral muscles. This finding is important in that it shows that in people with soft tissue replacement, the amount of protrusion of the upper lip may not increase at the same rate as the amount of protrusion of the incisors.

**Study limitations:** The limitations of our study are the presence of only protruding groups, not evaluating individuals with extraction fixed orthodontic treatment, and not measuring body mass index or variables that may affect upper lip tonicity. It should also be considered that the lower lip may influence the upper lip.

## Conclusion

A decrease in nasolabial angle and a decrease in upper lip protrusion were determined with upper incisor protrusion. However, a decrease in lip thickness was observed when the amount of protrusion increased. Therefore, as the amount of protrusion of the upper incisors increases, the reflections on the upper lip may not be at the same rate and should be kept in mind in treatment planning.

**Ethical approval:** The Van Yüzüncü Yıl University Non-interventional Research Ethics Committee provided its approval to this study, which was carried out in accordance with the Helsinki Declaration (permission date/number: 2021/12-21).

**Conflict of interest:** The authors declare that they have no conflict of interest for this study.

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