ORIGINAL ARTICLE

# Relationship between the Position of the Incisors and the Thickness of the Soft Tissues in the Upper Jaw: Cephalometric Evaluation

Marcello Maddalone[1], Federico Losi[2], Elisa Rota[3], Marco G Baldoni[4]


## Abstract

**Aim:** The aim of this study is to verify if the thickness of soft tissues and inclination of the incisors have some relation with profile, to analyze its relevance considering these two parameters separately and to screen how the combination of different inclinations and different thickness can generate different facial patterns.

**Materials and methods:** The study was performed on 47 Caucasian patients aged between 6 years and 16 years of divided into 24 males and 23 females. None of the patients presented craniofacial changes of syndromic nature. All patients presented a value of SNA in between 80° and 84°. The inclination of the upper incisor related to the bispinal plane was between 104° and 116°. Each radiograph has been digitized or analyzed directly in digital format. To analyze the relationships between soft tissues and position of the incisors using various cephalometric measures and statistical methodology were used.

**Results:** Analysing the general correlation between all the cephalometric parameters considered, the results found show that the thickness of the tissues had an effect in modifying the aesthetic profile with respect to the position of the incisors. The cephalometric parameters related to the esthetic profile of the maxilla are all linked by strong correlations, especially correlation between SU, ULA and LS were very high. The differences between the means were statistically significant for different groups. Using the values of Mx1 and thickness of the lip as independent variables, while the LS, SU, ULA and NLA values as dependent variables all results are significant with respect to the prediction $p < 0.05$.

**Conclusion:** Thickness of the soft tissues showed a significant influence on the profile with respect to the position of the incisors.

**Clinical significance:** Data obtained highlighted that thickness of the soft tissues must be taken into account before starting an orthodontic treatment in order to obtain best aesthetic results.


**Keywords:** Cephalometric values, Facial profile, Incisors position, Soft tissues thickness.

*International Journal of Clinical Pediatric Dentistry* (2019): 10.5005/jp-journals-10005-1667

## Introduction

The cephalometric analysis has over time found different applications in orthodontics, including diagnosis of malocclusions, prediction of skeletal growth, and the evaluation of the effects of orthodontic treatment. Today orthodontic and dental studies are mostly oriented to find and test new treatment devices or to evaluate new radiographic analysis.[1–8] Cephalometric analysis in the diagnostic field is still widely used to analyze, compare, and express the spatial relationships of the soft tissues and craniofacial and dentofacial complexes before the beginning of a treatment. The evaluation of the obtained data can be quantitative, with the use of measurements of distances and angles, or qualitative by superimposition of the laterolateral teleradiographs of the skull, which direct visualization of changes in the spatial relations of areas and anatomical landmarks. The cephalometric analysis is also particularly useful in evaluating the position of the incisors. Nevertheless, the study of the plaster models does not allow a correct analysis of this parameter because according to the cutting angle to the occlusal plane used to obtain the model, the inclination of the incisors can greatly vary.

A study conducted on a series of lateral radiographs analyzed by various orthodontists showed how the identification of cephalometric points can vary considerably according to the different clinical evaluations.[9] It must also be considered that the use of a single parameter does not provide certain information. Recent introduction of three-dimensional methods such as cone-beam computed tomography was able to solve part of the problems afflicting today's cephalometric studies, allowing a three-dimensional evaluation of the entire skull.

The evaluation of the relationship between the teeth and the face begins with the observation of the concordance between the interincisive midline lines and the skeletal midline lines: this type of observation makes it possible to highlight possible deviations and asymmetries between the two jaws. A second important aspect in the evaluation of the relationship between teeth and soft tissues is the incisal exposure with lips at rest that should have a

[1]Department of Medicine and Surgery, University of Milano Bicocca, Monza, Italy

[2–4]Department of Orthodontics, University of Milano Bicocca, Monza, Italy

**Corresponding Author:** Marcello Maddalone, Department of Medicine and Surgery, University of Milano Bicocca , Monza, Italy, Phone: +39-392-4655950, e-mail: marcello.maddalone@unimib.it

**How to cite this article:** Maddalone M, Losi F, Rota E, *et al.* Relationship between the Position of the Incisors and the Thickness of the Soft Tissues in the Upper Jaw: Cephalometric Evaluation. Int J Clin Pediatr Dent 2019;12(5):391–397.

**Source of support:** Nil

**Conflict of interest:** None

value between 1 mm; and 5 mm; changes in this value may be due to alterations in the length of the upper lip or the maxilla, taking into account that lips of increased thickness tend to reduce the incisal exposure. In addition to the evaluation of resting lips, it is particularly important to evaluate the patient while smiling.

### Rationale of the Study

Best position of the teeth and the best esthetic result cannot be defined solely by an analysis of the teeth and also an analysis of the skeletal structures can be incomplete because soft tissues can in fact vary significantly in thickness, length, and postural tone depending on the patient. Anthropological studies have shown the impossibility of predicting the shape of the face, taking into account only skeletal parameters. At the same time, soft tissues have frequently less consideration, starting from the assumption that a good occlusion automatically correlates to a harmonious aspect of the overlying tissues. The objective of this study was to first verify whether the thickness of the soft tissues and the inclination of the incisors have some relationship with the characteristics of the profile; once the presence of a relationship is demonstrated, we will analyze its relevance, considering these two parameters separately and then define how the combination of different inclinations and different thickness can give rise to different facial patterns. To avoid the variability due to an excessive number of parameters to take into consideration, the analysis will only focus on the maxilla.

## Materials and Methods

The study was performed on 47 Caucasian patients (24 males and 23 females) aged between 6 years and 16 years. None of the patients presented craniofacial changes of syndromic nature, and for each patient, a laterolateral teleradiography was performed before the beginning of any orthodontic treatment. All patients presented a value of SNA in between 80° and 84° according to the values proposed by Steiner in order to avoid the influence of an altered position or dimension of the upper jaw on the values analyzed. A final inclusion criterion was represented by the inclination of the upper incisor, which has been evaluated in relation to the bispinal plane defined by the cephalometric points ANS and PNS according to the values proposed by the European Board of Orthodontics: the values considered acceptable to define the position of the upper incisor as normoinclined is between 104° and 116°.

The laterolateral teleradiographs taken into consideration showed the patients in a condition of natural head position and in the case of alterations in the position of the skull, these were oriented on the basis of the Frankfurt plan. Each radiograph has been digitized or analyzed directly in the digital format so that the various measurements can be performed using a cephalometric analysis software.

To analyze the relationships between soft tissues and position of the incisors, various cephalometric measures were taken into consideration:

- Thickness of the upper lip according to Holdaway
- LS: distance from labial superior to TVL
- ULA: upper lip angle
- NLA: nasolabial angle
- SU: depth of the upper sulcus according to Holdaway.
- PN: Nasal prominence according to Holdaway
- Mx1: distance from the edge of the incisor above the line TVL according to Arnett
- Inclination of the columella.

## Statistical Analysis

The study was divided into three parts, the first of which analyzes the general correlation between all the cephalometric parameters considered, the second focuses on the relationship between incisors and thickness of the soft tissues, and the third analyzes the mean values of the four groups.

Pearson correlation coefficient, Shapiro–Wilk test, multiple linear regression analysis, Durbin–Watson test, one-way ANOVA variance analysis, *post hoc* Turkey test, and Levene test were used to analyze the data obtained.

## Results

The first part of the study involved the analysis of all 47 patients to evaluate the presence of significant correlations between the values analyzed using the Pearson correlation coefficient. The Pearson coefficient makes it possible to evaluate the linear relationship between two continuous variables and is expressed by means of an $r$ value ranging from −1 (perfect negative linear relation) to +1 (perfect positive linear relation); if the value is 0, there is no correlation between the two variables. All variables have a normal (or Gaussian) distribution as demonstrated by the Shapiro–Wilk test ($p > 0.05$) (Table 1).

The thickness of the upper lip has a strong correlation with the labial prominence ($r = 0.693$), the upper sulcus ($r = 0.692$), and the upper lip angle ($r = 0.735$) while a negative correlation was found with l nasolabial angle ($r = -306$).

The position of the upper incisor (Mx1) correlates significantly with the labial prominence ($r = 0.343$), the superior sulcus ($r = 0.312$), and the upper lip angle ($r = 0.309$); no relationships with the nasolabial angle were found.

The cephalometric parameters related to the esthetic profile of the maxilla are all linked by strong correlations; in particular the correlation among SU, ULA, and LS is very high.

The nasolabial angle shows a strong correlation with the labial prominence ($r = -0.374$) and the upper lip angle ($r = -0.410$) with $p < 0.01$; the relationship with the upper sulcus ($r = -0.342$) and the thickness of the soft tissues is instead less significant $p < 0.05$.

The analysis also evaluated the relationship of the nose and the columella with the other cephalometric measurements: the nasal prominence (PN) correlates closely with LS ($r = -0.762$), SU ($r = -0.738$), ULA ($r = -0.755$), Mx1 ($r = -0.445$), and with the thickness of the soft tissues ($r = -0.474$); the ratios of the columella with the other measures are similar to those of PN and the close relation with the nasolabial angle is also noted ($r = -0.627$).

The second part of the analysis focused on how the relationship between the thickness of the soft tissues and the position of the incisors can influence the profile; a multiple linear regression analysis was then performed using the values of Mx1 and thickness as independent variables, while the LS, SU, ULA, and NLA values were taken into account as dependent variables.

## Labial Prominence

Established Mx1 and thickness as independent variables, a multiple linear regression analysis was performed to verify whether it is possible to predict the extent of the labial prominence when the first two parameters change. The various assumptions necessary to perform this type of analysis were respected: the linearity was stability through partial regression graphs, the independence of the residues was ascertained by the Durbin–Watson test (1,303),

**Table 1:** Correlations in between different parameters examined

| | | *Thickness* | *Mx1* | *LS* | *SU* | *ULA* | *NLA* | *PN* | *Columella* |
|---|---|---|---|---|---|---|---|---|---|
| Thickness | Correlation of pearson | 1 | −0.270 | 0.693** | 0.692** | 0.735** | −0.306* | −0.474** | −0.309* |
| | Sign. (two tails) | | 0.067 | 0.000 | 0.000 | 0.000 | 0.037 | 0.001 | 0.034 |
| | *N* | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |
| Mx1 | Correlation of Pearson | −0.270 | 1 | 0.343* | 0.312* | 0.309* | 0.043 | −0.445** | −0.336* |
| | Sign. (two tails) | 0.067 | | 0.018 | 0.032 | 0.035 | 0.775 | 0.002 | 0.021 |
| | *N* | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |
| LS | Correlation of Pearson | 0.693** | 0.343* | 1 | 0.956** | 0.969** | −0.374** | −0.762** | −0.453** |
| | Sign. (two tails) | 0.000 | 0.018 | | 0.000 | 0.000 | 0.010 | 0.000 | 0.001 |
| | *N* | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |
| SU | Correlation of Pearson | 0.692** | 0.312* | 0.956** | 1 | 0.916** | −0.342* | −0.738** | −0.441** |
| | Sign. (two tails) | 0.000 | 0.032 | 0.000 | | 0.000 | 0.019 | 0.000 | 0.002 |
| | *N* | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |
| ULA | Correlation of Pearson | 0.735** | 0.309* | 0.969** | 0.916** | 1 | −0.410** | −0.755** | −0.440** |
| | Sign. (two tails) | 0.000 | 0.035 | 0.000 | 0.000 | | 0.004 | 0.000 | 0.002 |
| | *N* | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |
| NLA | Correlation of Pearson | −0.306* | 0.043 | −0.374** | −0.342* | −0.410** | 1 | −0.065 | −0.627** |
| | Sign. (two tails) | 0.037 | 0.775 | 0.010 | 0.019 | 0.004 | | 0.662 | 0.000 |
| | *N* | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |
| PN | Correlation of Pearson | −0.474** | −0.445** | −0.762** | −0.738** | −0.755** | −0.065 | 1 | 0.727** |
| | Sign. (two tails) | 0.001 | 0.002 | 0.000 | 0.000 | 0.000 | 0.662 | | 0.000 |
| | *N* | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |
| Columella | Correlation of Pearson | −0.309* | −0.336* | −0.453** | −0.441** | −0.440** | −0.627** | 0.727** | 1 |
| | Sign. (two tails) | 0.034 | 0.021 | 0.001 | 0.002 | 0.002 | 0.000 | 0.000 | |
| | *N* | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |

**Correlation is significant at 0.01 level (two tail)
*Correlation is significant at 0.05 level (two tail)

**Table 2:** Coefficients and standard errors of multiple linear regression analysis

| | *Non-standardized coefficients* | | *Standardized coefficients* | | |
|---|---|---|---|---|---|
| | *T* | *Std error* | *Beta* | *t* | *Sign.* |
| (*K*) | −1.948 | 0.763 | | −2.552 | 0.014 |
| Thickness | 0.693 | 0.060 | 0.847 | 11.612 | 0.000 |
| Mx1 | 0.427 | 0.054 | 0.572 | 7.842 | 0.000 |

and the absence of multicollinearity was defined by a tolerance level greater than 0.1. The regression model is able to define the LS value in a statistically significant way *F* (2.44) = 79.375, $p < 0.0005$, adj. $R2 = 0.773$. Both variables are significant with respect to the prediction $p < 0.05$; the coefficients and standard errors are shown in Table 2.

Established Mx1 and thickness as independent variables, a multiple linear regression analysis was performed to verify whether it is possible to predict the extent of the upper sulcus when the first two parameters change. The various assumptions necessary to perform this type of analysis were respected: linearity was stability using partial regression graphs, residual independence was ascertained by the Durbin–Watson test (1,242) and the absence of multicollinearity was defined by a tolerance level greater than 0.1. The regression model is able to define the LS value in a statistically significant way *F* (2.44) = 65.164, $p < 0.0005$, adj. $R2 = 0.736$. Both variables are significant with respect to the prediction $p < 0.05$; the coefficients and standard errors are shown in Table 3.

## Upper Lip Angle

Established Mx1 positions and thickness as independent variables, a multiple linear regression analysis was performed to verify whether it is possible to predict the extent of the upper lip angle as the first two parameters change. The various assumptions necessary to perform this type of analysis were respected: linearity was stability using partial regression graphs, residual independence was ascertained by the Durbin–Watson test (1,639), and the absence of multicollinearity was defined by a tolerance level greater than 0.1. The regression model is able to define the LS value in a statistically significant way *F* (2.44) = 99.029, $p < .0005$, adj. R2 = 0.810. Both

**Table 3:** Coefficients and standard errors of multiple linear regression analysis

| | | *Non-standardized coefficients* | | *Standardized coefficients* | | |
|---|---|---|---|---|---|---|
| *Model* | | *T* | *Std mistake* | *Beta* | *t* | *Sign.* |
| 1 | (*K*) | −0.648 | 0.722 | | −0.897 | 0.374 |
| | Thickness | 0.601 | 0.056 | 0.837 | 10.645 | 0.000 |
| | Mx1 | 0.353 | 0.052 | 0.538 | 6.845 | 0.000 |

**Table 4:** Coefficients and standard errors of multiple linear regression analysis

| | | *Non-standardized coefficients* | | *Standardized coefficients* | | |
|---|---|---|---|---|---|---|
| *Model* | | *T* | *Std mistake* | *Beta* | *t* | *Sign.* |
| 1 | (*K*) | −9.253 | 2.725 | | −3.396 | 0.001 |
| | Thickness | 2.819 | 0.213 | 0.883 | 13.229 | 0.000 |
| | Mx1 | 1.593 | 0.194 | 0.547 | 8.193 | 0.000 |

variables are significant with respect to the prediction $p < 0.05$; the coefficients and standard errors are shown in Table 4.

## Nasolabial Angle

Established Mx1 and thickness as independent variables, a multiple linear regression analysis was performed to verify whether it is possible to predict the extent of the nasolabial angle when the first two parameters change. One of the assumptions to carry out this test has not been respected since the distribution of the variables had no linear trend; however, using the test, an adj has been found ($R2 = 0.054$).

In the third part of the statistical analysis, the same sample was used divided into four groups according to the thickness of the tissues and inclination of the incisor. The 12-mm-thick measurement of the upper lip was used to discriminate between soft and thick soft tissues (Bergman), while three parameters were used to evaluate the inclination of the incisor in order to avoid possible classification errors owing to abnormal inclinations of the bispinal plane or of the N point; the parameters used are:

- Incisor inclination with respect to the bispinal plane (exoinclined >110°, endoinclined ≤110°)
- Distance between a perpendicular drawn from point A and the edge of the upper incisor (McNamara) (the average of the values found equal to 4.97 mm was used as the discriminating value, exoinclined >4.97, endo inclined ≤4.97)
- Distance of the upper incisor from the TVL (as a discriminating value the average of the values found was equal to −9.50 mm, exoinclined >−9.50, endoinclined ≤−9.50)

In case of discrepancy of one of the parameters, the position of the incisor was classified according to the indications given by the two accordant parameters. The groups obtained were defined in:

- Endo-thin: endoinclinated incisors and thin soft tissues ($n = 10$)
- Exo-thin: exo-inclined incisors and thin soft tissues ($n = 15$)
- Endo-thick: endoinclinated incisors and thick soft tissues ($n = 12$)
- Exo-thick: exo-inclined incisors and thick soft tissues ($n = 10$)

To evaluate whether there are significant differences between the various groups, a one-way ANOVA variance analysis was performed using LS, SU, ULA, and NLA cephalometric parameters as dependent variables. The ANOVA analysis was followed by a *post hoc* Turkey test, which was used to discriminate between groups with and without significant differences; the data were found to be distributed normally as shown by the Shapiro–Wilk test ($p > 0.05$) and the variances were homogeneous according to the Levene test ($p > 0.05$).

### Labial Prominence

The values relating to the labial prominence show an increase of this parameter starting from patients with thin and incisor soft tissues endoinclinated (0.48 ± 1.34), exo-inclined (1.93 ± 0.96), towards patients with thick soft tissues and endoinclinated incisors (2.50 ± 1.40) or exo-inclined (3.92 ± 1.22), in this order. The differences between the means found were statistically significant for each group ($p < 0.05$) with the exception of the exo-thin/endo-thick groups.

### Upper Lip Angle

The values related to the upper lip angle show an increase in this parameter starting from patients with thin and incisor soft tissues endoinclinati (2.73 ± 4.92), exo-inclined (7.33 ± 3.79), toward patients with thick soft tissues and incinctive endoinclinati (10.45 ± 5.89) or exo-inclined (15.91 ± 4.42), in this order. The differences between the means found were statistically significant for each group ($p < 0.05$) with the exception of the exo-thin/endo-thick, as well as exo-thin/endo-thin groups.

### Upper Lip Groove

The values relating to the upper labial groove show an increase in this parameter starting from patients with thin and incisor soft tissues endoinclinated (1.58 ± 1.04), exo-treated (3.04 ± 0.97), toward patients with thick soft tissues and endoinclinated (3.36 ± 1.43) or exoinclinated incisors (4.46 ± 0.98), in this order. The differences between the means found statistically significant for each group ($p < 0.05$) with the exception of the exo-thin/endo-thick groups.

**Table 5:** Differences between the averages found are not statistically significant

| | | | | | | 95% confidence interval | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | *N* | *Media* | *Std. deviation* | *Std error* | *Lower limit* | *Upper limit* | *Minimum* | *Maximum* |
| LS | Endo-thin | 10 | 0.4890 | 1.34971 | 0.42682 | −0.4765 | 1.4545 | −1.34 | 2.34 |
| | Exo-thin | 15 | 1.9353 | 0.96564 | 0.24933 | 1.4006 | 2.4701 | −0.24 | 3.09 |
| | Endo-thick | 12 | 2.5067 | 1.40686 | 0.40612 | 1.6128 | 3.4005 | −0.26 | 4.30 |
| | Exo-thick | 10 | 3.9270 | 1.22504 | 0.38739 | 3.0507 | 4.8033 | 1.76 | 5.75 |
| | Total | 47 | 2.1972 | 1.65508 | 0.24142 | 1.7113 | 2.6832 | −1.34 | 5.75 |
| ULA | Endo-thin | 10 | 2.7310 | 4.92968 | 1.55890 | −0.7955 | 6.2575 | −3.54 | 9.15 |
| | Exo-thin | 15 | 7.3373 | 3.79600 | 0.98012 | 5.2352 | 9.4395 | −0.98 | 12.34 |
| | Endo-thick | 12 | 10.4533 | 5.89776 | 1.70254 | 6.7061 | 14.2006 | −0.99 | 18.65 |
| | Exo-thick | 10 | 15.9180 | 4.42602 | 1.39963 | 12.7518 | 19.0842 | 9.21 | 22.20 |
| | Total | 47 | 8.9785 | 6.45681 | 0.94182 | 7.0827 | 10.8743 | −3.54 | 22.20 |
| SU | Endo-thin | 10 | 1.5860 | 1.04826 | 0.33149 | 0.8361 | 2.3359 | −0.40 | 3.18 |
| | Exo-thin | 15 | 3.0400 | 0.97216 | 0.25101 | 2.5016 | 3.5784 | 0.89 | 4.31 |
| | Endo-thick | 12 | 3.3642 | 1.43866 | 0.41530 | 2.4501 | 4.2782 | 0.38 | 5.30 |
| | Exo-thick | 10 | 4.4620 | 0.98733 | 0.31222 | 3.7557 | 5.1683 | 3.07 | 6.47 |
| | Total | 47 | 3.1160 | 1.45223 | 0.21183 | 2.6896 | 3.5423 | −0.40 | 6.47 |
| NLA | Endo-thin | 10 | 119.0490 | 7.61281 | 2.40738 | 113.6031 | 124.4949 | 104.81 | 133.45 |
| | Exo-thin | 15 | 117.6613 | 8.69228 | 2.24434 | 112.8477 | 122.4750 | 104.29 | 132.35 |
| | Endo-thick | 12 | 113.6333 | 8.36758 | 2.41551 | 108.3168 | 118.9498 | 100.05 | 126.27 |
| | Exo-thick | 10 | 112.2730 | 5.88510 | 1.86103 | 108.0631 | 116.4829 | 103.11 | 121.00 |
| | Total | 47 | 115.7817 | 8.07507 | 1.17787 | 113.4108 | 118.1526 | 100.05 | 133.45 |

### Nose-labial Angle

The values relating to the upper labial fissure show an increase in this parameter starting from patients with thin soft tissues and incisor endoinclinated (119.04 ± 7.61), exo-inclined (117.66 ± 8.69), toward patients with thick soft tissues and endoinclinated (113.63 ± 8.36) or exo-inclined incisors (112.27 ± 5.88), in this order. However, the differences between the averages found are not statistically significant ($p = 0.157$) (Tables 5 and 6).

## Discussion

Numerous studies have been carried out on the relationship between the bone bases and the overlying soft tissues with often contradictory results: Riedel states that the profile defined by the soft tissues is closely linked to the dento-skeletal component.[10] Subtenly indicates that not all parts of the profile directly follow the underlying bone tissue.[11] Burstone has suggested that there is not always a direct relationship between hard and soft tissues, indicating the cause of these discrepancies in the thickness of the tissues.[12] Stoner concluded that lip displacement appears to be associated with the movement of the incisors, while Wyle expresses the idea that the modalities of the profile following the orthodontic treatment do not depend on the inclination of the teeth.[13] According to Bloom, the growth of the tissues as well as the bone make it difficult to give a definitive answer about the relationship between soft tissues and hard tissues owing to a series of problems: usually the cephalometric analyses of the soft tissues and those of the bone bases are separated from each other; it is difficult to conduct a general analysis of the face and often some areas are not considered; the use of reference planes such as the Frankfurt plane or the Sella-Nasion plan can mask changes in the buccal region owing to skeletal growth; angular measures to define the position of the incisors may be incorrect because the root apex does not always remain in the same position of origin.[14]

More recent studies on the subject have generally been more in favor of the relationship between hard tissues and soft tissues, evaluating how the retraction of the incisors has a direct effect on the characteristics of the profile.

The correlation analysis (Table 1) showed that both the thickness of the soft tissues and the position of the incisors are closely related to the profile since the ratio coefficient has been shown to be highly significant for all the esthetic parameters evaluated; the only exception is represented by the nasolabial angle, which shows a significant relationship with the thickness of the tissues but not with the inclination of the incisor. A previous study conducted by Franklin and Hunter on patients in the first-division class II found very close correlations between the position of the incisor and the nasolabial angle during treatment, a sign that the incision of the incisors directly affects the appearance of the profile.[15] Although these data may appear to be in contrast, in reality the aforementioned study analyzes the variation of the incisal position in the same patients, where other parameters, such as tissue thickness or nasal prominence, remain constant; in this study, on the other hand, patients with different facial features have been analyzed that directly influence the width of the nasolabial angle that is most determined by the shape of the nose, as shown by the close relationship with the inclination of the columella. This result may therefore suggest that the nasolabial angle is a less reliable parameter in evaluating the orthodontic profile and movement since its value is more associated with the shape of the nose, which can only be modified using surgical treatments. The correlation analysis also shows how the development of soft tissue of the nose is directly linked to the

**Table 6:** Differences between the averages found are not statistically significant

| *Dependent variable* | *(I) class 2* | *(J) class 2* | *Medium difference (I–J)* | *Std error* | *Sign.* | *Confidence interval 95% Lower limit* | *Upper limit* |
|---|---|---|---|---|---|---|---|
| LS | Endo-thin | Exo-thin | −1.44633* | 0.50088 | 0.030 | −2.7849 | −0.1078 |
| | | Endo-thick | −2.01767* | 0.52533 | 0.002 | −3.4216 | −0.6138 |
| | | Exo-thick | −3.43800* | 0.54869 | 0.000 | −4.9043 | −1.9717 |
| | Exo-thin | Endo-thin | 1.44633* | 0.50088 | 0.030 | 0.1078 | 2.7849 |
| | | Endo-thick | −,57133 | 0.47518 | 0.629 | −1.8412 | 0.6985 |
| | | Exo-thick | −1.99167* | 0.50088 | 0.001 | −3.3302 | −0.6531 |
| | Endo-thick | Endo-thin | 2.01767* | 0.52533 | 0.002 | 0.6138 | 3.4216 |
| | | Exo-thin | 0.57133 | 0.47518 | 0.629 | −0.6985 | 1.8412 |
| | | Exo-thick | −1.42033* | 0.52533 | 0.046 | −2.8242 | −0.0164 |
| | Exo-thick | Endo-thin | 30.43800* | 0.54869 | 0.000 | 1.9717 | 4.9043 |
| | | Exo-thin | 1.99167* | 0.50088 | 0.001 | 0.6531 | 3.3302 |
| | | Endo-thick | 1.42033* | 0.52533 | 0.046 | 0.0164 | 2.8242 |
| ULA | Endo-thin | Exo-thin | −4.60633 | 1.94834 | 0.100 | −9.8131 | 0.6005 |
| | | Endo-thick | −7.72233* | 2.04344 | 0.003 | −13.1833 | −2.2614 |
| | | Exo-thick | −13.18700* | 2.13430 | 0.000 | −18.8908 | −7.4832 |
| | Exo-thin | Endo-thin | 4.60633 | 1.94834 | 0.100 | −0.6005 | 9.8131 |
| | | Endo-thick | −3.11600 | 1.84836 | 0.343 | −8.0556 | 1.8236 |
| | | Exo-thick | −8.58067* | 1.94834 | 0.000 | −13.7875 | −3.3739 |
| | Endo-thick | Endo-thin | 7.72233* | 2.04344 | 0.003 | 2.2614 | 13.1833 |
| | | Exo-thin | 3.11600 | 1.84836 | 0.343 | −1.8236 | 8.0556 |
| | | Exo-thick | −5.46467* | 2.04344 | 0.050 | −10.9256 | −0.0037 |
| | Exo-thick | Endo-thin | 13.18700* | 2.13430 | 0.000 | 7.4832 | 18.8908 |
| | | Exo-thin | 8.58067* | 1.94834 | 0.000 | 3.3739 | 13.7875 |
| | | Endo-thick | 5.46467* | 2.04344 | 0.050 | 0.0037 | 10.9256 |
| SU | Endo-thin | Exo-thin | −1.45400* | 0.46029 | 0.015 | −2.6841 | −0.2239 |
| | | Endo-thick | −1.77817* | 0.48275 | 0.003 | −3.0683 | −0.4880 |
| | | Exo-thick | −2.87600* | 0.50422 | 0.000 | −4.2235 | −1.5285 |
| | Exo-thin | Endo-thin | 1.45400* | 0.46029 | .015 | 0.2239 | 2.6841 |
| | | Endo-thick | −0.32417 | 0.43667 | 0.879 | −1.4911 | 0.8428 |
| | | Exo-thick | −1.42200* | 0.46029 | 0.018 | −2.6521 | −0.1919 |
| | Endo-thick | Endo-thin | 1.77817* | 0.48275 | 0.003 | 0.4880 | 3.0683 |
| | | Exo-thin | 0.32417 | 0.43667 | 0.879 | −0.8428 | 1.4911 |
| | | Exo-thick | −1.09783 | 0.48275 | 0.120 | −2.3880 | 0.1923 |
| | Exo-thick | Endo-thin | 2.87600* | 0.50422 | 0.000 | 1.5285 | 4.2235 |
| | | Exo-thin | 1.42200* | 0.46029 | 0.018 | 0.1919 | 2.6521 |
| | | Endo-thick | 1.09783 | 0.48275 | 0.120 | −0.1923 | 2.3880 |
| NLA | Endo-thin | Exo-thin | 1.38767 | 3.21169 | 0.973 | −7.1953 | 9.9707 |
| | | Endo-thick | 5.41567 | 3.36845 | 0.385 | −3.5863 | 14.4176 |
| | | Exo-thick | 6.77600 | 3.51823 | 0.233 | −2.6262 | 16.1782 |
| | Exo-thin | Endo-thin | −1.38767 | 3.21169 | 0.973 | −9.9707 | 7.1953 |
| | | Endo-thick | 4.02800 | 3.04688 | 0.554 | −4.1146 | 12.1706 |
| | | Exo-thick | 5.38833 | 3.21169 | 0.348 | −3.1947 | 13.9713 |
| | Endo-thick | Endo-thin | −5.41567 | 3.36845 | 0.385 | −14.4176 | 3.5863 |
| | | Exo-thin | −4.02800 | 3.04688 | 0.554 | −12.1706 | 4.1146 |
| | | Exo-thick | 1.36033 | 3.36845 | 0.977 | −7.6416 | 10.3623 |
| | Exo-thick | Endo-thin | −6.77600 | 3.51823 | 0.233 | −16.1782 | 2.6262 |
| | | Exo-thin | −5.38833 | 3.21169 | 0.348 | −13.9713 | 3.1947 |
| | | Endo-thick | −1.36033 | 3.36845 | 0.977 | −10.3623 | 7.6416 |

*Medium difference is significant at the 0.05 level development of soft tissues that overhang the jaw according to tissue-growth studies by Subtelny.[11]

The linear regression analysis (Tables 2 to 4) was useful to better investigate how the position of the incisor and the thickness of the tissues affect these parameters and to what extent: the results found show that together, the thickness of the tissues and the position of the incisor can explain 77% of the variability of the lip prominence, 73% of the variability of the depth of the upper sulcus, and 81% of the variability of the inclination of the upper lip angle. In particular, the regression analysis showed that an increase of 1 mm in the thickness of the tissues, given as constant the position of the incisor, leads to an increase of 0.69 mm of the labial prominence, 0.60 mm of the depth of the labial sulcus higher, and a 2.8° increase in the width of the upper lip angle. Even the position of the incisor, at the same thickness, can influence the profile in a quantity that an increase of 1 mm in the exoinclination of the upper incisor leads to an increase of 0.42 mm in the prominence of the lip, 0.35 mm in the depth of the upper labial sulcus, and 1.5° amplitude increase of the upper lip angle. Given these values, it is possible to state that the thickness of the tissues has a greater influence on the profile with respect to the position of the incisors and therefore this parameter must be evaluated before starting an orthodontic treatment in order to predict the esthetic results.

The third part of the statistical analysis (Tables 5 and 6) focused on the analysis of possible combinations between incisal position and thickness of the tissues: the results found show that the thickness of the tissues has, even in this case, a greater effect in modifying the esthetic profile with respect to the position of the incisors. Lip prominence, upper lip angle, and upper labial groove have higher values in patients with thick soft tissues than thin ones; exo-inclined incisors are associated with increased values both in patients with thin tissues and thick tissues. The only groups, common to all three parameters, that do not show significant differences despite having different averages are the exo-thin and endo-thick groups. In this case, the lack of significance can be explained by the fact that thin soft tissues tend to follow more closely the position of the incisors with respect to the thick soft tissues, which remain more stable; this implies that in the case of exo-inclined incisors and thin soft tissues, the position of the incisors and the increased displacement of the tissues can compensate for the lack of thickness, thus making negligible the difference with patients characterized by thick inclinations and thick soft tissues.

## Conclusion

Different esthetic cephalometric parameters studied in this work showed significative statistical correlations with lip position.

## Clinical Significance

Thickness of the tissues showed a significant influence on the profile with respect to the position of the incisors, highlighting that this parameter should be everytime taken into account before starting an orthodontic treatment in order to obtain best esthetic results.

## References


1. Maddalone M, Ferrari M, et al. Use of miniscrew implants in orthodontic distal movement [Utilizzo delle miniviti nelle meccaniche ortodontiche di distalizzazione]. Dental Cadmos 2010;78(8):97–105.
2. Maddalone M, Ferrari M, et al. Intrusive mechanics in orthodontics with the use of TAD's [Utilizzo delle miniviti nelle meccaniche ortodontiche di distalizzazione]. Dental Cadmos 2010;78(7):97–106.
3. Maddalone M. The association between the psychological status and the severity of facial deformity in orthognathic patients. Angle Orthodontist 2012;82(3):396–402. DOI: 10.2319/060211-363.1.
4. Citterio F, Pellegatta A, et al. Analysis of the apical constriction using micro-computed tomography and anatomical sections. Giornale Italiano Di Endodonzia 2014;28:41–45. DOI: 10.1016/j.gien.2014.05.001.
5. Venino PM, Citterio CL, et al. A Micro–computed Tomography Evaluation of the Shaping Ability of Two Nickel-titanium Instruments, HyFlex EDM and ProTaper Next. J Endod 2017;43(4):628–632. DOI: 10.1016/j.joen.2016.11.022.
6. Maddalone M, Gagliani M, et al. Prevalence of vertical root fractures in teeth planned for apical surgery. A retrospective cohort study. Int Endod J 2018 Feb 25;51(9):969–974. DOI: 10.1111/iej.12910.
7. Maddalone M, Mirabelli L, et al. Long-term stability of autologous bone graft of intraoral origin after lateral sinus floor elevation with simultaneous implant placement. Clin Implant Dent Relat Res 2018 Aug 24;20(5):713–721. DOI: 10.1111/cid.12649.
8. Porcaro G, Busa A, et al. Use of a partial-thickness flap for Guided Bone regeneration in the upper jaw. J Contemp Dent Pract 2017 Dec 1;18(12):1117–1121. DOI: 10.5005/jp-journals-10024-2186.
9. Jacobson A, Jacobson RL. Radiographic Cephalometry: From Basics to 3-D Imaging. s.l.: Quintessence Publishing Co, Inc; 2006.
10. Little RM, Riedel RA, et al. An evaluation of changes in mandibular anterior alignment from 10 to 20 years postretention. Am J Orthod Dentofacial Orthop 1988 May;93(5):423–428. DOI: 10.1016/0889-5406(88)90102-3.
11. Subtelny JD. The Soft Tissue Profile, Growth And Treatment Changes. The Angle Orthodontist 1961;31:105–122.
12. Burstone CJ. Lip posture and its significance in treatment planning. Am J Orthod 1967;53:262–284. DOI: 10.1016/0002-9416(67)90022-X.
13. Bronson JR, Stoner CC. Optimal sagittal appliance mechanics. Funct Orthod 1984 Jul–Aug;1(2):43–44.
14. Bloom DR, Padayachy JN. Esthetic changes with four anterior units. Br Dent J 2006 Feb 11;200(3):135–138. DOI: 10.1038/sj.bdj.4813192.
15. Dénarié S, Gebeile-Chauty S, et al. Esthetic repercussions of the class II treatment on the profile: comparative study Distal Activ Concept (DAC)/Extra-Oral Force (EOF). Orthod Fr 2010 Sep;81(3):209–220. DOI: 10.1051/orthodfr/2010019.