ORIGINAL ARTICLE

Facial soft tissue changes after orthodontic treatment

S Aksakalli, A Demir[1]

Departments of Orthodontics, Faculty of Dentistry, Bezmialem Vakif University, Istanbul, [1]Mevlana University, Konya ,Turkey

Abstract

Objectives: To successfully meet expectations on facial esthetics, it is important to understand normal craniofacial growth and the impact of orthodontic treatment thereon. To date, there have been few studies documenting changes in facial esthetics through photography. The objective of this study was to compare facial soft tissue esthetics before and after orthodontic treatment by means of photographic analysis.

Materials and Methods: The 45 children were divided into 3 groups according to Angle's classification: Groups I, II, and III comprised children with class I, II, and III malocclusion, respectively. Photographs were analyzed with a software. Twenty-one soft tissue landmarks were identified on profile and frontal photographs, ratios and angles were calculated.

Results: For group I, there was no difference between pre- and post-treatment facial analysis. For group II, there were significant changes in 5 values. The most significant changes were observed for A-N-B and Al-Me/Ch-Me. For group III, we noted significant changes for 5 values. The most significant change was observed for N-Pn-Pog.

Conclusion: There were significant changes in facial soft tissue esthetics after orthodontic treatment for class II and III cases. Changes in A-N-B and nose tip angle (N-Pn-Cm) were observed for class II and class III subjects.

Key words: Aesthetics, photograph, soft tissue

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Introduction

In the past, orthodontists were mainly concerned with the correction of skeletal and dental relationships. Nowadays, however, establishing ideal facial esthetics is also a major concern in orthodontic treatment. This is because patients expect to see better facial esthetics or smile, and an orthodontic treatment that impairs esthetics leads to low patient satisfaction.[1,2]

To successfully meet expectations on facial esthetics, it is important to understand normal craniofacial growth and the impact of orthodontic treatment thereon. Studies on craniofacial growth and facial esthetics typically evaluate soft tissues using cephalograms.[3] Similar studies focusing on profile changes are based on the relationship between lip and incisor.[3-6] However, several other factors affect facial esthetics, such as forehead, nose, and chin morphology. When compared to the other anatomical regions, the oral region is the one where facial esthetics is more effectively achieved; as a result, proper correction of oral-dental problems increases the patient's self-confidence and attractiveness.[7]

Nonetheless, controversy remains regarding the effectiveness of orthodontic treatment for facial esthetics. On the one hand, orthodontic treatment has been shown to improve facial esthetics in class II malocclusion patients; on the other hand, it has had very low esthetic effect in class III malocclusion patients.[8,9] In another study, O'Neill *et al.*,[10] also reported no significant changes in facial esthetics after functional treatment.

To date, there have been few studies documenting changes in facial esthetics through photography. The objective of this study was to compare facial soft tissue esthetics before and after orthodontic treatment by means of photographic analysis.

Address for correspondence:
Dr. Sertac Aksakalli,
Bezmialem Universitesi, Dis Hekimliği Fakultesi, Ortodonti AD,
Vatan Cad, Fatih, Istanbul, Turkey.
E-mail: sertacaksakal@gmail.com

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Materials and Methods

The materials for this study were provided by the Faculty of Dentistry, Selcuk University. Subjects were 45 Turkish children who were treated at the Department of Orthodontics. Patients who satisfied the following inclusion criteria were selected: No previous orthodontic treatment; no history of craniofacial or dental trauma; no history of maxillofacial or plastic surgery; having healthy parents who were blood relatives (no adopted or stepchildren); no usage of glasses; and having frontal and profile extra oral photographs in our archive. The confirmation for the biological relationship between parents and child was done by questionnaire and identification cards that were given by Turkish government.

The children were divided into 3 groups according to Angle's classification: Groups I, II, and III comprised children with class I, II, and III malocclusion, respectively. The ages of children in each of the 3 groups are shown in Table 1. All children were treated with fixed orthodontic mechanics.

All photographs were taken with a photographic camera (Nikon D80; Nikon Corp., Japan) and telescopic lens (Micro-Nikkor 105 mm; Nikon Corp., Japan). Frontal photographs were taken with the interpupillary plane parallel to the floor plane; teeth were in centric occlusion with relaxed facial muscles. Profile photographs were taken with soft tissue Frankfort horizontal plane parallel to the floor plane; teeth were in centric occlusion.

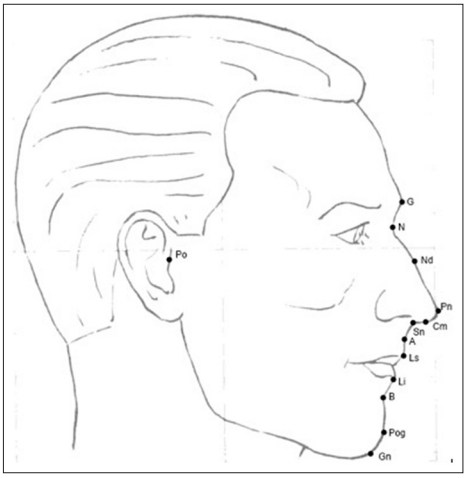

Figure 1: Profile soft tissue landmarks used in this study. G: Glabella, N: Nasion, Po: Porion, Nd: Nasal dorsum, Pn: Pronasale, Cm: Columella, Sn: Subnasale, (a) A point, Ls: Labiale superior, Li: Labiale inferior, (b) B point, Pog: Pogonion, Gn: Gnathion. Angles: Nose tip angle (N-Pn-Cm), Nasolabial angle (Cm-Sn-Ls), Nasomental angle (N-Pn/N-Pog), Mentolabial angle (Li-B-Pog), Nasofrontal angle (G-N-Nd), Total convexity with nose (N-Pn-Pog), Total convexity except nose (G-Sn-Pog), Soft tissue ANB angle, Upper lip projection angle (N-Pog/N-Ls), Upper lip projection angle (N-Pog/N-Li)

Photographs were analyzed with Quickceph software (Quick Ceph Systems Inc., USA). Twenty-one soft tissue landmarks were identified on profile and frontal photographs. The landmarks are shown and defined in Figures 1 and 2.

After measurement of soft tissue variables, calculations were performed using a statistical method: Because there are normal distributions according to Kolmogorov-Smirnov test, a paired t test was used to determine significance of pre- and post-treatment changes. Statistical evaluations were performed with SPSS 17.0 (SPSS Inc., Chicago, USA). For all tests, the level of significance was set at $P < 0.05$.

All measurements were performed by the same operator (S.A.). To determine reliability, the same operator repeated all measurements one month later. Intraoperator error was assessed by using the Dahlberg method [Table 2].[11]

Results

For group I, there was no difference between pre- and post-treatment facial analysis [Table 3]. Because clinicians do not try to change facial soft tissue values in these cases, these results are acceptable. But all the changes can be related with growth and development process.

Table 1: Mean ages and treatment times of the groups

Group	*N*	Mean pre-treatment age	Min	Max	SD	Total treatment time
I	15	12. 6	11.1	14	0.66	1. 2
II	15	11. 9	10.9	13.6	0.6	1. 9
III	15	11. 6	11	12.8	0.48	2. 3

SD=Standard deviation

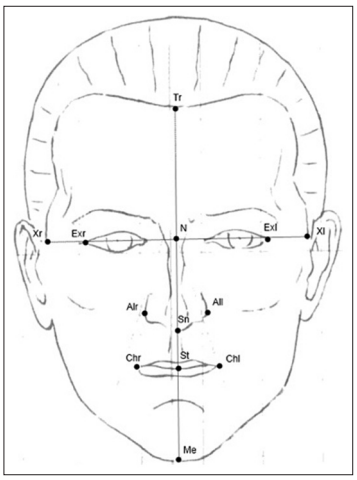

Figure 2: Frontal soft tissue landmarks used in this study. Tr: Trichion, N: Nasion, Sn: Subnasale, Exr: Exocanthion right, Exl: Exocanthion left, Alr: Alare right, All: Alare left, Xr: The most right point according to bipupillary line, Xl: The most left point according to bipupillary line. Ratios: Tr-N/Sn-Me, N-Sn/Sn-Me, Sn-St/St-Me, XR-XL/Tr-Me, Ex-Me/Ex-Tr, Al-Me/Ex-Al, Al-Me/Ch-Me, Ch-Me/Al-Ch, ChR-ChL/AlR-AlL

For group II, there were significant changes in 5 values (XR-XL/Tr-Me, Al-Me/Ch-Me, N-Pn-Cm, A-N-B, and N-Pog/N-Ls). The most significant changes were observed for A-N-B and Al-Me/Ch-Me [Table 4]. After the treatment, the soft tissue esthetics was improved by establishing ideal sagittal relationships. The vertical changes such as XR-XL/Tr-Me, Al-Me/Ch-Me for group II can be due to fixed mechanics. In these cases, intermaxillary elastics with vertical components were used.

For group III, we noted significant changes for 5 values (N-Pn-Cm, N-Pn/N-Pog, Li-B-Pog, N-Pn-Pog, and A-N-B). The most significant change was observed for N-Pn-Pog [Table 5]. Similarly, with group II, the corrected sagittal relationships can be found. Because of the changes of lower incisor positions after treatment, Li-B-Pog changed.

Times for finishing treatments were longer than group I, so it can be assumed that the effect of growth increased in group II and III. So, there are more vertical and nasal changes such as N-Pog/N-Ls or N-Pn-Pog in group II and III.

Discussion

For group I, the nasolabial angle (Cm-Sn-Ls) decreased but not significantly ($P = 0.609$). There are other studies in the literature that are in agreement with this result.[12,13] Weyrich and Lisson[14] did not find any significant differences in the nasolabial angle of growing subjects, but Hamamci *et al.*[15] did. In this study, the position of the lip was found to be more retracted, but this difference was not

Table 2: Methods errors for measurements used in this study

Measurements	Method error
Profile photograph analysis	
Tr-N/Sn-Me (r)	0.02
N-Sn/Sn-Me (r)	0.01
Sn-St/St-Me (r)	0.01
XR-XL/Tr-Me (r)	0.01
Ex-Me/Ex-Tr (r)	0.02
Al-Me/Ex-Al (r)	0.07
Al-Me/Ch-Me (r)	0.02
Ch-Me/Al-Ch (r)	0.05
ChR-ChL/AlR-AlL (r)	0.02
N-Pn-Cm (d)	0.37
Cm-Sn-Ls (d)	0.68
N-Pn/N-Pog (d)	0.74
Li-B-Pog (d)	1.58
G-N-Nd (d)	0.32
N-Pn-Pog (d)	0.69
G-Sn-Pog (d)	1.34
A-N-B (d)	0.31
N-Pog/N-Ls (d)	0.19
N-Pog/N-Li (d)	0.33
N-Po-Sn (d)	0.5
Sn-Po-Gn (d)	0.64

d=Degree; r=Ratio

Table 3: The significance of facial esthetic changes between pre- and post-treatment for Group I

Measurement	*P* value
Tr-N/Sn-Me (r)	0.9
N-Sn/Sn-Me (r)	0.256
Sn-St/St-Me (r)	0.218
XR-XL/Tr-Me (r)	0.71
Ex-Me/Ex-Tr (r)	0.22
Al-Me/Ex-Al (r)	0.096
Al-Me/Ch-Me (r)	0.077
Ch-Me/Al-Ch (r)	0.111
ChR-ChL/AlR-AlL (r)	0.243
N-Pn-Cm (d)	0.67
Cm-Sn-Ls (d)	0.609
N-Pn/N-Pog (d)	0.609
Li-B-Pog (d)	0.67
G-N-Nd (d)	0.532
N-Pn-Pog (d)	0.733
G-Sn-Pog (d)	0.629
A-N-B (d)	0.82
N-Pog/N-Ls (d)	0.932
N-Pog/N-Li (d)	0.875
N-Po-Sn (d)	0.378
Sn-Po-Gn (d)	0.955

r=Ratio; d=Degree

Table 4: The significance of facial esthetic changes between pre- and post-treatment for Group II

Measurement	*P* value
Tr-N/Sn-Me (r)	0.66
N-Sn/Sn-Me (r)	0.659
Sn-St/St-Me (r)	0.568
XR-XL/Tr-Me (r)	0.019
Ex-Me/Ex-Tr (r)	0.393
Al-Me/Ex-Al (r)	0.887
Al-Me/Ch-Me (r)	0.001
Ch-Me/Al-Ch (r)	0.205
ChR-ChL/AlR-AlL (r)	0.065
N-Pn-Cm (d)	0.02
Cm-Sn-Ls (d)	0.535
N-Pn/N-Pog (d)	0.073
Li-B-Pog (d)	0.134
G-N-Nd (d)	0.056
N-Pn-Pog (d)	0.178
G-Sn-Pog (d)	0.148
A-N-B (d)	0.001
N-Pog/N-Ls (d)	0.005
N-Pog/N-Li (d)	0.194
N-Po-Sn (d)	0.334
Sn-Po-Gn (d)	0.087

r=Ratio; d=Degree

Table 5: The significance of facial esthetic changes between pre- and post-treatment for Group III

Measurement	*P* value
Tr-N/Sn-Me (r)	0.694
N-Sn/Sn-Me (r)	0.909
Sn-St/St-Me (r)	0.704
XR-XL/Tr-Me (r)	0.362
Ex-Me/Ex-Tr (r)	0.078
Al-Me/Ex-Al (r)	0.55
Al-Me/Ch-Me (r)	0.232
Ch-Me/Al-Ch (r)	0.348
ChR-ChL/AlR-AlL (r)	0.442
N-Pn-Cm (d)	0.044
Cm-Sn-Ls (d)	0.887
N-Pn/N-Pog (d)	0.012
Li-B-Pog (d)	0.02
G-N-Nd (d)	0.088
N-Pn-Pog (d)	0.001
G-Sn-Pog (d)	0.125
A-N-B (d)	0.025
N-Pog/N-Ls (d)	0.23
N-Pog/N-Li (d)	0.306
N-Po-Sn (d)	0.552
Sn-Po-Gn (d)	0.649

r=Ratio; d=Degree

significant ($P = 0.609$). Longitudinal studies by Bishara *et al.*[16] and Nanda *et al.*[17] concluded similar results. With regard to facial convexity, our results showed stability, supporting the findings of similar studies.[16,18]

For group II, our findings showed straightening of facial convexity through a decrease in A-N-B ($P = 0.001$) and N-Pog/N-Ls ($P = 0.005$) angles. Meyer-Marcotty *et al.*[19] found similar results in their study with class II subjects. This may be due to anterior positioning of the mandible. In our study, vertical dimensions showed an increase according to XR-XL/Tr-Me ($P = 0.019$) and Al-Me/Ch-Me ($P = 0.001$) ratios. The increase of vertical values can be expressed by the skeletal augmentation of anterior facial height during treatment of class II subjects.[20,21]

In group III, profile convexity was reduced according to N-Pn-Pog ($P = 0.012$) and A-N-B ($P = 0.025$) angles. For class III subjects, reduction of profile concavity can be determined.[22,23] In this study, correction of A-N-B angle occurred at a lesser extent than in group II. Kiekens *et al.*[8] stated that the A-N-B angle was less efficiently corrected in class III than in class II subjects. Therefore, class III patients should be informed about post-treatment expectations following orthodontic treatment.

Researching the effects of orthodontic treatment can help determining its limits, possibilities, and strategies for achieving ideal facial esthetics. Clinicians show great confidence in the so-called ideal ratios and angles, which can be used to draw guidelines. However, little evidence is available on the relationship between facial characteristics and facial esthetics.[8]

Our study has some limitations. The sample size can be increased, more facial landmarks could have been measured, and different races or ethnicities can be taken into account. Post-treatment analysis could have been performed at longer follow-up time points. The sample size could be increased, but in this kind of studies, it was difficult to perform a retrospective study on only a group of patients treated with fixed orthodontic mechanics.

The angles and ratios used in this study were calculated directly from landmark values. Perpendiculars, projections, or reference axes were not used. This type of restrictions were followed to eliminate projection errors and to perform simpler and more applicable measurements.

To evaluate facial esthetics, anthropometrics, silhouettes, photographs, videos, and cephalograms can be used. Photographs are easier to use than anthropometrics; photographs also allow researchers to study larger areas as compared to silhouettes, are cheaper than three-dimensional records, and emit no radiation, contrary to cephalograms.[24-26]

In our study, differences in gender were not taken into account. It is known that pubertal peak stages are different for boys and girls. However, according to Halazonetis,[27] differentiating groups per gender at any pubertal stage is meaningless. There are also similar studies performed with mother-offspring and father-offspring groups.[28,29]

Different types of treatment were not evaluated in this study. However, according to O'Neill *et al.*,[10] the type of treatment has no effect on facial esthetics. Similarly, in another study, Isiksal *et al.*[30] researched the effect of extraction and non-extraction treatments on smile esthetics and concluded that the effect on smile esthetics was irrespective of the type of treatment.

Conclusions

Within the limitations of this study, the following conclusions can be drawn:

- There were significant changes in facial esthetics after orthodontic treatment for class II and III cases
- Significant changes in A-N-B and nose tip angle (N-Pn-Cm) were observed for class II and class III subjects.

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