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ORIGINAL ARTICLE

Soft Tissue Profile Changes in Anatolian Turkish Girls and Boys Following Orthodontic Treatment With and Without Extractions

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Abstract: The choice of extraction is critical in treatment planning, and its impact on the final facial appearance can be quite dramatic. Evaluation of facial profile esthetics both before and after treatment should be made cautiously. An orthodontist should be conscious of changes brought about by treatment and by late adolescent growth as well as differences in the dentofacial structures of various ethnic groups. The purpose of this cephalometric investigation was to determine the changes in the soft tissue profile of Turkish children treated with and without extractions. An assessment of pre- and post-treatment faces, chosen from our clinical records by certain criteria, was made to determine the possible variations between the 2 treatment alternatives. The material comprised the lateral cephalometric radiographs of 30 extractions (20 girls, 10 boys) and 30 non-extraction Class I patients (20 girls, 10 boys) both treated with edgewise appliances. The changes resulting from treatment in both groups were determined by paired t tests. May to further test whether the variables were statistically different for the groups both before and after treatment, independent sample t tests were used. After treatment, upper and lower lips were more retrusive, while the inferior sulcus as measured to the H line showed an increase in the extraction group. However, the average soft tissue measurements after treatment for both groups were favorable.

Key Words: Premolar extraction, Profile changes, Facial esthetics

Introduction

Success in orthodontic practice is closely related to observable enhancement in the esthetic outcome(s) of the treatment, may therefore evaluating facial profile esthetics, both before and after treatment, is an integral part of the orthodontic treatment philosophy. Several authors (1,2) hold a strongly negative view of extraction treatment because they believe that such therapies produce dished-in profiles, flatten the face and make the lips more retrusive thus giving the individual an older appearance.

The debate concerning the detrimental effects of extracting teeth is as old as orthodontics itself and has not yet resulted in any consensus (3). Dr. Edward Angle (4), known as the father of modern orthodontics, believed that the dental arches should be expanded to include all the teeth and that an ideal balance and harmony of the face can only occur if all of the teeth are maintained in the ideal occlusion. Unlike Angle, Case (5) stated that expanding the dental arches that much and ignoring extraction would not guarantee long term stability, let alone esthetic improvement. Additionally, other authors (6-8) including students of Angle's, later verified the therapeutic advantages of extraction therapies.

Bravo et al. (9), Bishara et al. (10), Cummins et al. (11) and Kocadereli (12) concluded that after treatment, the upper and lower lips are more retrusive in those patients subjected to extraction. Furthermore, Bishara et al. (10) argue that extraction patients tend to have straighter faces and slightly more upright maxillary and mandibular incisors, whereas non-extraction patients have the opposite tendencies.

After evaluating the changes in the facial profile following orthodontic treatment with extractions, other studies have asserted that "flattening of the face" is not likely in the majority of cases (13, 14). In a sample group

of 160 patients treated with removal of first premolars, 80 to 90% of patients had soft tissue measurements that suggested the profile was improved by treatment or remained satisfactory throughout treatment [15]. Similarly, Bravo [16] argued that only 12% of patients in his sample finished treatment with a clearly more flattened facial profile.

According to scientific investigations, cephalometric norms differ from one population to another. For the examination of facial profile changes in a population it is justified to evaluate individuals within their original ethnic and racial norms. Attempts were made to develop cephalometric standards for different ethnic groups (17-26). The main soft tissue responses of African-Americans following extraction were found to be more retruded upper and lower lips and an increased nasolabial angle (27). Caplan and Shivapuja (28) found that a significant profile change did occur following the extraction of 4 first premolars and subsequent orthodontic therapy in adult African-American females. The results of their study indicated that the retraction of the lower lip correlates with retraction of both maxillary and mandibular anterior teeth.

This study is intended to address the pre- and post-treatment soft tissue profile changes in Turkish children treated with and without extractions. We think that it would be very beneficial to determine the effects of 4 first premolar extractions, particularly in the lips area, which seems to be exposed to greatest changes by treatment, and to discuss whether these changes are compatible with Anatolian Turkish norms.

Materials and Methods

The study included 60 white patients presenting Angle Class I malocclusions without a severe craniofacial anomaly. Steiner's ANB and GoGnSN angles were used for distinguishing skeletally normal patients from individuals with skeletal Class II, Class III and vertical anomalies. Only patients presenting with 1 to 4 degrees of ANB and 27 to 37 degrees of GoGnSN were included. No extractions were made in 30 patients (10 boys and 20 girls) and 4 first premolar extractions were made in the other 30 (10 boys and 20 girls). Extractions of maxillary and mandibular 4 first premolars were made in order to eliminate dental crowding in the extraction group. Mean values of crowding were 2.45 ± 1.98 mm in the upper arch and 2.29 ± 2.03 mm in the lower arch for the non-extraction group. In the extraction group, crowding was 7.62 ± 2.25 in the upper arch and 8.85 ± 2.33 mm in the lower arch. All of the patients were between 12 and 14 years of age at the beginning of the treatment. The mean ages were 12.94 years in the extraction group and 12.73 years in the non-extraction group.

All patients were treated by standard edgewise appliances. Total treatment time was between 12 and 26 months. The treatment objectives for both the extraction and non-extraction groups were to ideally align the incisors, establish an excellent occlusion with teeth interdigitated and resolve tooth size arch length discrepancies while maintaining the original arch form. The patients had no previously extracted or congenitally missing permanent teeth except for the third molars. No surgery patients were included.

The soft tissue measurements used to evaluate the facial profile changes in this study were made using pre- and post-treatment lateral cephalometric radiographs taken at the beginning and the end of treatment. All radiographs were taken on the same cephalostat with the patient in a standing position, with the Frankfort plane parallel to the horizontal, the teeth in centric occlusion and lips relaxed. All radiographs were traced and measured by same investigator (S.A.). Both pre- and post-treatment radiographs were retraced and remeasured at l-month intervals by the same investigator to ensure measurement accuracy using the paired t tests. No differences were found in the remeasurements ($p > .05$) and the mean values of the 1st and 2nd measurements for each parameter were used in later analysis. The changes resulting from treatment in both groups were determined by the paired t tests. May to further test whether the variables were statistically different for the groups both before and after treatment, independent sample t tests were used. All statistical analyses were performed with the SPSS software package (SPSS 10.0 for Windows).

The soft tissue profile measurements include 8 linear and 3 angular parameters. For the linear measurements of the soft tissue landmarks, the locations behind the E line and H line were recorded as negatives (-) and those in front of these lines were recorded as positives (+). The following measurements were used (Figures 1 and 2) :

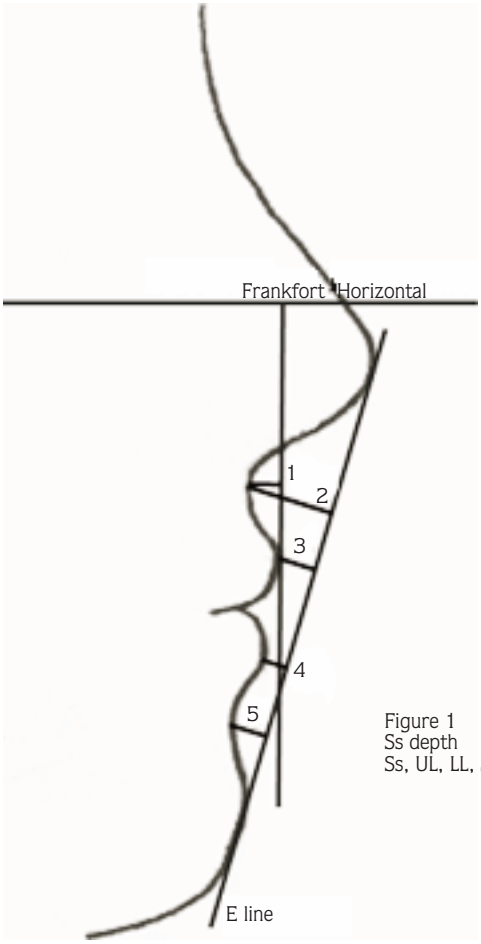

Figure 1
Ss depth
Ss, UL, LL, Si to E line

Figure 1. Sulcus Superior Depth (1).
Measurements of Ss (2), UL (3), LL (4), Si (5) to E line.

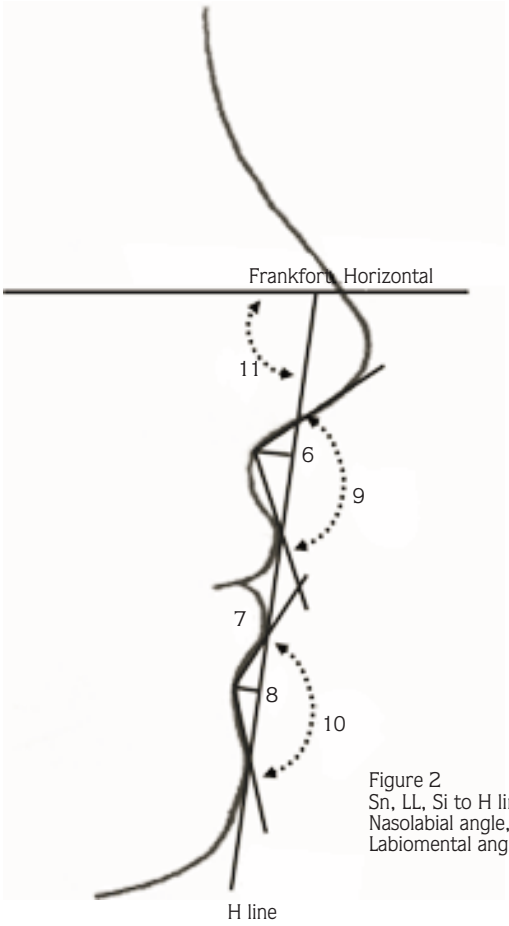

Figure 2
Sn, LL, Si to H line
Nasolabial angle,
Labiomental angle, Z angle

Figure 2. Measurements of Sn (6), LL (7), Si (8) to H line.
Nasolabial angle (9).
Labiomental angle (10).
Z angle (11).

Linear Measurements

Sulcus Superior Depth: Sulcus superior depth (1) as described by Holdaway (29) is measured as the distance from the sulcus superior to the line tangent to the vermilion border of the upper lip and perpendicular to the Frankfort horizontal. He determined a range of 1 to 4 mm as acceptable, with 3 mm being ideal.

E Line: The line tangent from the tip of the nose to the end of the chin was termed the esthetic plane by Ricketts (30). In younger patients he determined the ideal location of the lower lip to the E line as 0 mm (ranging from (-) 3 mm to (+) 3 mm). In adults his measurements showed a mean of (-) 4 mm. In this study, the distances (mm) from the upper (3) and lower lips (4) to the E- line and the distances (mm) from the sulcus superior (2) and sulcus inferior (5) to Ricketts' line of esthetics were measured.

H Line: The H line, as introduced by Holdaway (29), is drawn tangentially to the soft tissue chin and the upper lip. The ideal position of the lower lip to the H line is 0 to 0.5 mm anterior, although variations from 1 mm behind to 2 mm in front of the H line are considered to be within a normal range. The distances (mm) from the subnasale (Sn) (6), lower lip (7), and sulcus inferior (8) to the H-line were analyzed in this study.

Angular Measurements

Nasolabial Angle: Nasolabial angle (9) is defined as the angle between the line tangent from the Sn to the

lower border of the nose and the line from the Sn to upper lip. According to Fitzgerald et al.(31) the mean value of the angle in a sample of 104 young white adults with well balanced faces was 114° ± 10°. Several studies of pleasing profiles indicate a range of 90° to 120° for the parameter.

Labiomental angle: Labiomental angle (10) is formed by the intersection of a line drawn between the sulcus inferior and soft tissue chin and a line originating at the sulcus inferior tangent to lower lip. Nanda et al. (32) determined that at 18 years the mean value of the angle was 125.1° ± 12.9° in males and 127.1° ± 12.9° in females.

Z Angle: The Z angle (11), which is formed by the intersection of the Frankfort horizontal plane and a line tangent to the soft tissue chin and the most procumbent lip, was developed by Merrifield (33) in a sample group of untreated normal individuals and formerly treated patients with pleasing facial esthetics. He found the normal range of the angle to be between 72° and 83°.

Results

Descriptive statistics (mean ± SD) for changes in soft tissue facial profile following orthodontic treatment with and without extractions are given in Tables 1 and 2. The mean values for Ss depth, lower lip to E line, lower lip to H line and sulcus inferior to H line were statistically different between the extraction and non-extraction groups prior to treatment ($p < .05$). Surprisingly, these values were not significant when comparing the final results between the 2 groups ($p > .05$). Statistically significant changes in lower lip to E line ($p = .008$), lower lip to H line ($p = .049$) and sulcus inferior to H line ($p = .002$) occurred in the extraction group. In other words, extraction patients started treatment with fuller lower lips and displayed less protrusive lower lips at the end. Additionally, the inferior sulcus as measured to the H line tended to increase after treatment in the extraction group.

The increase in Z angle for non-extraction patients and the decrease in nasolabial angle for both extraction and non-extraction groups were statistically significant ($p < .05$). The mean values of these angles were close to each other in the comparison of the 2 groups after treatment. According to statistical data, only the mean values of the upper lip to the E line ($p= .000$) and the Sn to the H line ($p = .005$) were significantly different between 2 groups after treatment although the groups showed no differences prior to treatment ($p> .05$) and the changes during treatment were not statistically significant for these parameters ($p> .05$).

Discussion

Orthodontists mostly evaluate soft tissue profile by means of silhouettes or, as included in this paper, linear and angular measurements made from lateral

Table 1. Inter-group Comparisons.

	Before Treatment			After Treatment		
Variables	Non-extraction	Extraction	p	Non-extraction	Extraction	p
Ss depth (mm)	-2.11 ± 1.2	-1.4 ± 1	.02 *	-1.6 ± 1	-1.2 ± .8	.08
Ss-E line (mm)	-9.5 ± 1.2	9.0 ± 2.2	.25	-9.2 ± 1.2	-9.3 ± 2.5	.93
UL-E line (mm)	-2.8 ± 1.7	-3.6 ± 2.3	.14	-2.3 ± 1.6	-4.7 ± 2.7	.00 †
LL-E line (mm)	-2.6 ± 2	-1.3 ± 1.7	.01 *	-1.8 ± 2.7	-3.3 ± 3.4	.06
Si-E line (mm)	-6.7 ± 2.3	-6.7 ± 1.5	.99	-6.9 ± 2	-6.4 ± 2.2	.31
Sn-H line (mm)	-5.6 ± 2.5	-5.4 ± 1.5	.75	-5.9 ± 1.84	-4.7 ± 1.5	.005 †
LL-H line (mm)	-1.1 ± 2.4	.2 ± 1.5	.01 *	-1.1 ± 2.4	-.6 ± 1.8	.34
Si-H line (mm)	-6.4 ± 1.9	- 4.1 ± 2	.00 *	-6.2 ± 1.7	-6.0 ± 2.4	.74
NL angle (°)	120.1 ± 9.5	116.6 ± 11	.18	111.9 ± 8.3	110.5 ± 9.5	.55
LM angle (°)	120.1 ± 13	123.6 ± 11	.28	119 ± 12.7	122.9 ± 14	.27
Z angle (°)	69.2 ± 5.8	71.5 ± 6	.14	73.9 ± 6.4	74.2 ± 7.6	.86

* Statistically significant differences between extraction and non-extraction groups before treatment ($p < .05$).

† Statistically significant differences between extraction and non-extraction groups after treatment ($p < .05$).

Table 2. Intra-group Comparisons.

	Non-extraction (n=30)			Extraction (n=30)		
Variables	Before	After	p	Before	After	p
Ss depth (mm)	-2.11 ± 1.2	-1.6 ± 1	.12	-1.4 ± 1	-1.2 ± .8	.56
Ss-E line (mm)	-9.5 ± 1.2	-9.2 ± 1.2	.38	-9.0 ± 2.2	-9.3 ± 2.5	.68
UL-E line (mm)	-2.8 ± 1.7	-2.3 ± 1.6	.25	-3.6 ± 2.3	-4.7 ± 2.7	.08
LL-E line (mm)	-2.6 ± 2	-1.8 ± 2.7	.21	-1.3 ± 1.7	-3.3 ± 3.4	.008 ‡
Si-E line (mm)	-6.7 ± 2.3	-6.9 ± 2	.72	-6.7 ± 1.5	-6.4 ± 2.2	.55
Sn-H line (mm)	-5.6 ± 2.5	-5.9 ± 1.84	.56	-5.4 ± 1.5	-4.7 ± 1.5	.05
LL-H line (mm)	-1.1 ± 2.4	-1.1 ± 2.4	.95	.2 ± 1.5	-.6 ± 1.8	.049 ‡
Si-H line (mm)	-6.4 ± 1.9	-6.2 ± 1.7	.67	- 4.1 ± 2	-6.0 ± 2.4	.002 ‡
NL angle (°)	120.1 ± 9.5	111.9 ± 8.3	.002 ‡	116.6 ± 11	110.5 ± 9.5	.019 ‡
LM angle (°)	120.1 ± 13	119 ± 12.7	.71	123.6 ± 11	122.9 ± 14	.83
Z angle (°)	69.2 ± 5.8	73.9 ± 6.4	.003 ‡	71.5 ± 6	74.2 ± 7.6	.11

‡ Statistically significant differences between pre-treatment and post-treatment average values in both extraction and non-extraction groups ($p < .05$).

cephalometric radiographs. However, there is no specific method for measuring esthetics. Facial "attractiveness" is due to individuality and highly related to self-perception. It has no standards and the most "beautiful" face as perceived by the public would not match the average person's face (34). Perhaps a profile radiograph alone is not sufficient to determine the balance of the face because even observable 2-dimensional changes are often exposed to the negative effects of nose and chin growth. As no other technological means currently exist, orthodontists need to use careful judgment and include patients' esthetic desires in treatment planning.

Measurements and clinical observations of soft tissues require careful attention because of individual variations in thickness and regional independence of the underlying skeleton. Changes in profile seem to be related to variables such as pretreatment lip strain, variations in lip structure and thickness, and incisor retraction (35). It is important that the orthodontist be conscious not only of changes imparted by treatment, but also of those changes brought about by late adolescent and postpubertal growth (36). Many studies (36-38) demonstrated the changes in soft tissue from earlier ages to late adulthood. Bishara et al. (38) found that the upper and lower lips became significantly more retruded in relation to the esthetic line between 15 and 25 years of age and the same trends continued between 25 and 45 years of age.

Some authors criticize the use of the E line to assess profile esthetics because it is often exposed to the negative effects of the size of the nose and remaining growth. In this study, upper and lower lips as measured to the E line moved slightly back after treatment in the extraction group compared to the non-extraction group. Finnoy et al. (39) found mean changes of (-) 3.3 mm for the upper lip to the E line and (-) 2.5 mm for the lower lip to the E line in a sample of 30 Class II, Div 1 extraction cases treated with edgewise appliances. According to Battagel (40), these changes were (-) 4.4 mm for the upper lip to the E line and (-) 2.3 mm for the lower lip to the E line in a group of 30 patients with a mean age of 12.7 years treated with edgewise appliances after the extraction of upper first premolars. In another study by Drobocky and Smith (15), upper and lower lips moved back an average of 3.4 mm and 3.6 mm relative to the E line in a sample of 160 patients after the removal of 4 first premolars. Similar changes were reported by Bravo (16). In this study, mean differences of (-) 1.1 mm for the upper lip to the E line and (-) 2.2 mm for lower lip to E line occurred in the extraction group. The mean changes in these linear variables were positively correlated, yet slightly less than the results of the other studies cited.

An evaluation of soft tissue profile in Anatolian Turkish adults (41) indicated that the upper and lower lips were retrusive according to the norms of Steiner and Ricketts. According to the results of that study, upper and lower lips to E line distances were (-) 5.4 mm and (-) 4.5 mm in dentally normal groups and (-) 5.2 mm and (-) 3.5

mm in both dentally and skeletally normal groups. At the completion of the treatment, both non-extraction and extraction groups in our study displayed slightly fuller lips than those Anatolian Turkish adult norms.

In contrast to the E line, the H line has been widely advocated by researchers because it is not affected by the size of the nose. Sağlam and Gazilerli (42) examined the 5-year changes in Holdaway measurements due to growth and development in Anatolian Turkish boys and girls between 9 and 12 years of age. The results of their study showed that all measurements were significant at various levels in boys and girls except for upper lip sulcus depth, subnasal-H line distance and the lower lip to the H line, all 3 of which were measured in this study. According to the results of that study, the sulcus inferior to H line distance increased over time in girls and boys. They also found that the changes in Holdaway measurements in boys and girls showed similarities.

In this study, the mean values for the lower lip to the H line and the sulcus inferior to the H line were statistically different between the extraction and non-extraction groups prior to treatment. Our current findings showed that the sulcus inferior to the H line tended to deepen and the lower lip became retruded to the H line in the extraction group whereas the non-extraction group showed almost no change. However, on average the non-extraction group displayed a slightly retrusive lower lip to the H line after treatment. In a study conducted by Başçiftçi et al. (43) Holdaway soft tissue norms in Anatolian Turkish adults were determined. They found that generally most measurements were similar to the Holdaway norms. It was concluded that, after treatment, both groups evaluated in our study were compatible with the results of that study except for the lower lip to the H line which was found to be slightly more retrusive and closer to the lower limit of the Holdaway norm, ranging from (-) 1 mm to (+) 2 mm, in both groups.

Extraction and non-extraction groups showed significant decreases in changes of nasolabial angle. However, after treatment, statistically significant differences were not determined between the 2 groups. Nanda et al. (32) reported that the nasolabial angle decreased slightly from 7 to 18 years of age in both sexes with the mean at 7 years at 107.8° ± 9.4° for boys and 114.7° ± 9.5° for girls. At 18 years, the means were 105.8° ± 9.0° for men and 110.7° + 10.9° for women. Lo and Hunter (44) found no significant changes in nasolabial angle because of growth. In addition, they reported that the greater the maxillary incisor retraction, the greater the increase in nasolabial angle.

Statistically significant increases were recorded for the Z angle in the extraction group. The groups were not statistically different after treatment because both groups showed parallel changes. These findings agreed with James' (45) study with a sample of 108 extraction and 62 non-extraction patients. That study showed similar increases in both groups after treatment. In our study, post-treatment mean values of the Z angle in extraction and non-extraction patients were 74.2° ± 7.6° and 73.9° ± 6.4°, whereas in Anatolian Turkish adults the mean values were 69.1° ± 7.4° in dentally normal and 69.0° ± 6.6° in dentally and skeletally normal groups (41). Post-treatment mean values of the Z angle for both groups in our study were close to each other and also closer to the mean value of the angle as described by Merrifield (33). Thus, in the present study, the Z angle was found to be more obtuse after treatment for both groups and this change enhanced the results.

Measuring esthetics is very difficult to achieve. Improvement in one measurement may not result in favorable changes in another. Angular measurements of a patient may be within normal ranges, and yet there is a presence of protrusion of the incisors and the upper and lower lips. A comparison of different soft tissue analyses in the determination of Anatolian Turkish beauty indicated that among the 7 esthetic lines used to evaluate the soft tissue profile, only Ricketts' norms for upper and lower lips corresponded to the values for attractive profiles (46). Therefore, the consequences regarding profile esthetics should not be judged by numbers alone.

Conclusions

Pretreatment lip protrusion is an important characteristic that might influence the extraction decision in Turkish Anatolian patients who were previously concluded to have retrusive upper and lower lips according to original norms as described by Ricketts and Steiner.

The extraction group showed a fuller lip profile prior to treatment and the lip protrusion lessened with treatment.

The mean finished profile assessment for both extraction and non-extraction patients fell within the pleasing normal ranges of the parameters studied.

On average, non-extraction patients had less facial change as a result of orthodontic treatment.

Even though the facial profile value means of both the extraction and non-extraction groups were compatible with Anatolian Turkish adult norms at the completion of treatment, when late adolescent and postpubertal growth changes were taken into account, a flattening of the profile might still occur in the individual patient at a later age.

In planning treatment for growing patients, orthodontists should not treat them according to adult standards, which reflect a more retrusive profile.

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