Changes in the Soft Tissue Profile after Extraction Orthodontic Therapy

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ABSTRACT

Purpose: The purpose of this study was to evaluate the effects of extraction therapy and use or nonuse of headgear on the soft tissue profile in subjects with different growth patterns.

Methods: A total of 41 subjects were included in the study. The patients were treated with standard edgewise mechanics and had 4 first premolars extracted. The type of growth pattern was assessed as mesiodivergent or hyperdivergent. The results were analyzed by 2-way analysis of variance.

Results: When comparing the mean changes between growth pattern types, the vertical changes in Sn and A' were found to be statistically significant ($P<.05$). The vertical change in A' was also found to be significant between the headgear use and nonuse groups ($P<.05$). Interaction was found to be significant for Steiner upper and lower lip values and the vertical change in A'. The upper and lower lips were retracted significantly more by headgear use in patients with hyperdivergent growth pattern ($P<.05$).

Conclusions: The results of this study indicate that the use of headgear should be avoided in hyperdivergent patients. The avoidance of premolar extraction, based on the possibility of a significant detrimental effect on the facial profile, is not justified. (J Dent Child 2006;73:164-169)

KEYWORDS: PREMOLAR EXTRACTION, SOFT-TISSUE PROFILE, HEADGEAR

Success in orthodontic treatment is closely tied to favorable changes in the facial soft tissue.[1] The interrelationship of soft tissue components of the face, such as nose, lip, and chin, changes with orthodontic treatment and during growth.[2,3] There are only a few studies concerning the positive or negative effects of premolar extraction on the facial profile. It has been verified that therapeutic extraction of premolars is followed by changes in the soft tissue profile.[4-6] The facial profile established during treatment is primarily the result of diagnosis and treatment mechanics.[7-9] It has been indicated that there is no basis for the statement that premolar extraction treatment leads to undesirable flattening of the facial profile.[10,11]

Drobocky and Smith[5] and Young and Smith[12] declared that it was incorrect to blame undesirable post orthodontic treatment facial esthetics on premolar extractions. Drobocky and Smith[5] concluded that the extraction of 4 first premolars generally did not result in a dished-in profile. Other authors[13,14] also claimed that the facial profile is not flattened significantly more by extraction of first premolars.

Bishara et al[15] indicated that the extraction or nonextraction decision, if based on sound diagnostic criteria, seems to have no deleterious effects on the soft tissue profile.

Mc Laughlin and Bennett[11] point out that there are some clinical situations in which the facial profile may become slightly flattened, irrespective of whether extraction or nonextraction treatment is performed. A patient with a significantly retruded dentition relative to the chin and nose may exhibit some facial flattening, even when treated on a nonextraction basis and when every attempt has been made to keep the profile as full as possible. The facial profile may become slightly flattened due to the existing skeletal pattern. Besides, some cases with excessively long lower facial heights that are treated without surgery may show some facial flattening.[11]

The aim of this study was to evaluate the effects of different growth patterns and the use or nonuse of headgear on the soft tissue profile in subjects treated with fixed standard edgewise mechanics who had 4 first premolars extracted.

METHODS

Forty-one subjects treated by the authors were selected accord-

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ing to the mandibular plane angle (SN/GoGn) angle. The mandibular plane angle was used to determine the vertical growth pattern of the patients. The ANB angle was used to consider the sagittal relationship of the jaws (skeletal Class 1 or Class 2; 0 º to 7º).

A total of 41 subjects with a mean chronological age of 14 years, 7 months and a skeletal age of 14 years, 6 months were included in the study. The subjects were classified according to their growth pattern and treatment type (Table 1). The growth pattern was assessed as either mesiodivergent (SN/GoGn 27º to 37º) or hyperdivergent (SN/GoGn≥38º). The treatment type included the use or nonuse of headgear (cervical headgear was applied to the mesiodivergent and high-pull headgear to the hyperdivergent patients) when it was necessary to increase anchorage. A combination of the mesio- and hyperdivergent patients to whom headgear was not applied formed the headgear nonuse group. The force of headgear used on one side was 350 g and patients used it until the end of canine retraction. As a result, 4 subgroups were constructed: (1) mesiodivergent+headgear; (2) mesiodivergent+no headgear; (3) hyperdivergent+headgear; and (4) hyperdivergent+no headgear (Table 1).

Table 1. Definition of Groups (Growth Pattern and Treatment Type) and Subgroups (Mesiodivergent, Hyperdivergent, Headgear, No Headgear)

	n=41	Treatment Type	
Growth Pattern	Mesiodivergent SN/GoGn 27-37	With Headgear n=12	Without Headgear n=12
		Age:10.83-18.08 years ANB 0-7	Age:11.75-19.08 years ANB 0-7
	Hyperdivergent SN/GoGn 27-37	n=8	n=9
		Age:11.00-20.05 years ANB 3-7	Age:10.92-19.08 years ANB 0-7

The 2 groups (growth pattern and treatment type) were matched according to the means of their chronological and skeletal ages (Table 1). All subjects had angle Class I (n=30) or Class II, division 1 (n=11) malocclusions with moderate (0-mm to 6-mm arch discrepancy) or severe crowding (>7 mm), and none of them showed any sign of lip strain. The basic upper lip thickness can be compared to upper lip thickness at the vermilion border to determine the amount of upper lip strain or incompetency present as the patient closes his/her lips over protrusive teeth. One millimeter is considered to be normal.[16] They were treated with standard edgewise mechanics, and the 4 first premolars were extracted. The decision to extract 4 premolars was taken with respect to the total arch circumferential discrepancy (more than 7 mm). The mean treatment time was 2 years, 10 months.

Lateral cephalometric and hand-wrist radiographs were taken before and after treatment in the same unit using the same equipment. The cephalometric radiographs were traced by hand and measured by one investigator up to 0.5 degrees or millimeters. The hand-wrist radiographs were assessed according to the method of Greulich and Pyle, where the developmental stages of the hand-wrist bones are matched with the appropriate stages in the Greulich and Pyle atlas.[17] The measurements were made according to the x to y (RL_x to RL_y) coordinate system. RL_x was constructed 7º to the original cranial base,[18] and RL_y was constructed perpendicular to RL_x at sella. The landmarks and measurements used are shown in Figure 1.

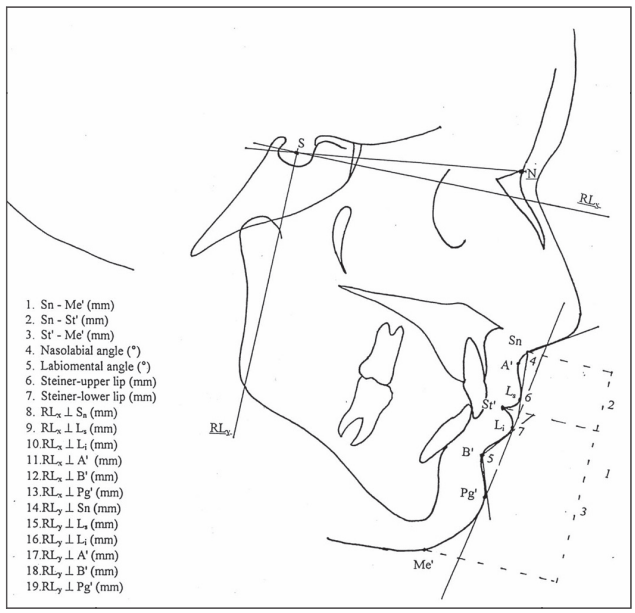


Figure 1. Angular and linear measurements used in the present study.

Sn: (Sousnasale) The deepest concavity under the nose before the philtrum begins. A': The deepest concavity on the mid region of the philtrum showing a reflection of point A on the soft tissue. Ls: (Lip superior) The most procumbent point on the upper lip. St: (Stomion) The junction point of the upper and lower lips. Li: (Lip inferior) The most procumbent point on the lower lip. B': The deepest concavity below the lower lip and above the chin area. Pg': The most procumbent point on the chin. Me': (Menton) The lowest point on the soft tissue chin. RLx: Horizontal reference line. RLy: Vertical reference line. S: (Sella) The midpoint at sella turcica. N: (Nasion) The most anterior point of the fronto-nasal suture in the mid-sagittal plane. Go: (Gonion) The most posterior inferior point on the contour of the angle of the mandible. Gn: (Gnathion) The most anterior inferior point on the contour of the bony chin. A: The deepest concavity of anterior palatal bone curve. B: The deepest concavity of lower anterior interdental bone curve.

STATISTICAL ANALYSIS

This study's results were assessed according to a 2X2 design:

1. The growth-pattern factor had 2 levels:
   a. mesiodivergent; and
   b. hyperdivergent.
2. The treatment type factor had 2 levels:
   a. use of headgear; and
   b. nonuse of headgear.

The treatment changes (Table 2) were analyzed for each variable by 2-way analysis of variance (ANOVA).[19] Growth

pattern factor X treatment type factor interaction was assessed for each parameter.

RESULTS

To analyze the potential error of the method during cephalometric tracing and measurements, 20 of the lateral cephalometric radiographs were selected randomly. Both the tracings and the measurements were repeated at least 15 days later. By using the 2 values for each measurement, repeatability coefficients were calculated via 2-way ANOVA. The coefficients were found to be very close to 1.00.

The treatment changes obtained from the 2-way ANOVA for each group are shown in Table 2. The vertical changes in Sn and in A' were found to be significantly different between the mesiodivergent and hyperdivergent groups. Interaction was found to be significant for Steiner upper lip, Steiner lower lip, and the vertical change in A' values. Therefore, these values were assessed separately.

ASSESSMENT OF INTERACTION

STEINER UPPER LIP

1. Hyperdivergent group (Table 3): The difference between headgear and no headgear subgroups ([-2.75]-[-0.994]) was found to be statistically significant (P<.05; Figure 2).
2. Headgear group (Table 3): The difference ([-0.958]-[-2.75]) between mesio- and hyperdivergent subgroups was found to be statistically significant (P<.05; Figure 2).

STEINER LOWER LIP

Hyperdivergent group (Table 4): The difference ([-2.437]-[-0.222]) between headgear and no headgear subgroups was found to be statistically significant (P<.05; Figure 3).

VERTICAL CHANGE IN A' ($RL_x \perp A'$)

1. Hyperdivergent group (Table 5): The difference ([-5.500]-[-1.167]) between headgear and no headgear subgroups was found to be statistically significant (P<.05; Figure 4).
2. Headgear group (Table 5): The difference ([-1.292]-[-5.500]) between the mesio- and hyperdivergent subgroups was found to be statistically significant (P<.05; Figure 4).

DISCUSSION

It is recognized by all clinical orthodontists that success of orthodontic treatment is closely related to facial soft tissue changes. Many studies concerning the effects of orthodontic treatment on the facial profile have focused on predictive aspects of the relationship between the incisor position to changes in lip protrusion. In these investigations, the patient's profile and whether it has been improved by treatment has not been considered.

This study's main purpose was to investigate the effects of extraction therapy on the soft tissue profile, depending on the growth pattern and the use/nonuse of headgear. The growth pattern was assessed as being either mesiodivergent (average type, SN/GoGn=27° to 37°) or hyperdivergent (SN/GoGn≥38°[20,21] (Table 1). The results obtained from the 2-way ANOVA, which give the interrelations of the effects of different growth pattern types, and treatment types are shown in Table 2.

SAGITTAL CHANGE

Luecke and Johnston[10] studied the effects of extraction therapy and found that the soft tissue profile appeared to have been influenced more profoundly by nose and chin growth. Talass et al,[3] Bishara et al,[15] and Andresen et al[22] found that the lower lip prominence decreased in cases treated with 4 first premolar extractions and Edgewise Mechanics.

Table 2. The Changes That Occurred During Treatment and Comparison of Changes Between Growth Pattern Types and Treatment Types

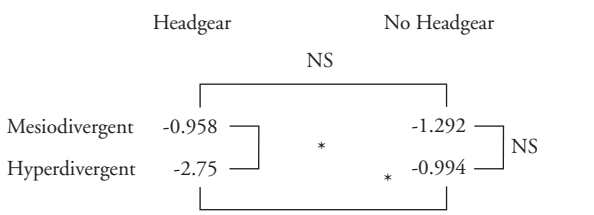
		Mesio-divergent n=24		Hyper-divergent n=17			With Headgear n=20		Without Headgear n=20		
		$\overline{D}$	S_D	$\overline{D}$	S_D	P	$\overline{D}$	S_D	$\overline{D}$	S_D	P
1.	Sn - Me' (mm)	3.44	0.15	3.44	0.22	NS	2.97	0.19	3.91	0.18	NS
2.	Sn - St' (mm)	0.88	0.18	0.10	0.02	NS	0.14	0.03	0.84	0.18	NS
3.	St' - Me' (mm)	2.63	0.54	3.31	0.80	NS	2.88	0.64	3.06	0.67	NS
4.	Nasolabial angle (°)	-3.56	0.73	-5.72	1.39	NS	-5.53	1.24	-3.75	0.82	NS
5.	Labiomental angle (°)	1.94	0.40	-3.27	0.79	NS	2.40	0.22	-3.73	0.81	NS
6.	Steiner-upper lip (mm)	-1.13	0.23	-1.85	0.45	NS	-1.85	0.42	-1.12	0.24	NS
7.	Steiner-lower lip (mm)	-1.27	0.26	-1.33	0.32	NS	-1.76	0.39	-0.84	0.18	NS
8.	$RL_x \perp S_n$ (mm)	0.35	0.07	2.83	0.69	NS	2.52	0.56	0.67	0.15	NS
9.	$RL_x \perp L_s$ (mm)	1.27	0.26	3.17	0.77	NS	2.83	0.63	1.61	0.35	NS
10.	$RL_x \perp L_i$ (mm)	1.73	0.35	3.80	0.92	NS	3.30	0.74	2.22	0.49	NS
11.	$RL_x \perp A'$ (mm)	1.21	0.25	3.33	0.81	NS	3.40	0.76	1.15	0.25	*
12.	$RL_x \perp B'$ (mm)	1.85	0.38	3.71	0.90	NS	3.58	0.80	1.98	0.43	NS
13.	$RL_x \perp Pg'$ (mm)	3.79	0.77	4.00	0.97	NS	5.08	1.14	2.71	0.59	NS
14.	$RL_y \perp S_n$ (mm)	1.08	0.22	1.00	0.24	NS	0.73	0.16	1.35	0.30	NS
15.	$RL_y \perp L_s$ (mm)	0.17	0.03	0.14	0.04	NS	-0.68	0.15	0.99	0.22	NS
16.	$RL_y \perp L_i$ (mm)	-0.40	0.08	0.31	0.07	NS	-0.75	0.22	0.66	0.14	NS
17.	$RL_y \perp A'$ (mm)	0.38	0.08	0.21	0.05	NS	-0.05	0.01	0.63	0.14	NS
18.	$RL_y \perp B'$ (mm)	0.33	0.07	0.07	0.02	NS	-0.37	0.08	0.77	0.17	NS
19.	$RL_y \perp Pg$ (mm)	0.35	0.07	0.89	0.22	NS	-0.41	0.09	1.65	0.30	NS
20.	ANB (°)	0.06	0.05	-0.39	0.07	NS	-0.77	0.06	0.44	0.06	**
21.	SN/GoGn (°)	-0.10	0.10	0.35	0.14	NS	0.13	0.12	0.13	0.11	NS

**** P<0.05 ** P<0.01 *** P<0.001***

Yogosawa[23] found that upper lip retraction was about 40% and lower lip retraction was about 70% of the maxillary incisor retraction.

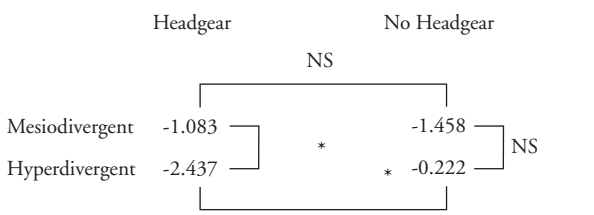
In this current investigation, comparison of the retraction of the upper and lower lips did not show any significant differences between the mesio- and hyperdivergent groups nor between the headgear use and nonuse groups (Table 2). But interaction was found to be significant for Steiner upper lip and Steiner lower lip values (Tables 3, 4, 5). Therefore, these parameters were assessed separately. The upper and lower lips showed a significantly greater retraction as a result of headgear usage in patients with hyperdivergent growth pattern. The significant difference between mesio- and hyperdivergent subjects in the use of headgear group concerning the upper lip reveals the downward growth pattern of hyperdivergent patients. All these results indicate that headgear use should be avoided in hyperdivergent patients, especially if the upper and lower lips are retruded at the beginning of orthodontic treatment.

Table 3. Comparison of the Differences for Steiner Upper Pil Value Between and No Headgear Subgroups Within Mesiodivergent and Hyperdivergent Groups



**** P<0.05 NS Nonsignificant***

Table 4. Comparison of the Differences for Steiner Upper Pil Value Between and No Headgear Subgroups Within Mesiodivergent and Hyperdivergent Groups



**** P<0.05 NS Nonsignificant***

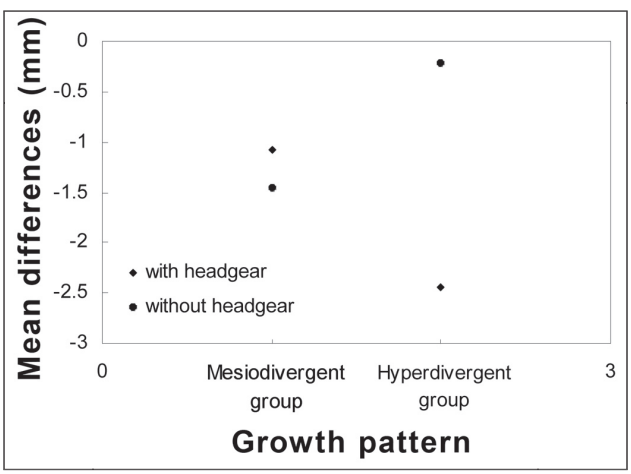


Figure 2. The mean values of Steiner upper lip (the differences and their significance are shown in Table 6).

VERTICAL CHANGES

According to Nanda et al,[24] the distance between soft tissue subnasale and upper lip stomion and lower lip height increased from ages 7 to 18 years. Genecov et al[25] found that the soft tissue lower facial height increased by growth. Abdel Kader[26] found that no change occurred in the distance between the upper and the lower lips, although overjet and overbite measurements showed significant reductions during treatment. Wilson et al[27] found significant changes in upper and lower lip length in a late premolar extraction group. Talass et al[3] showed the increase in the lower lip length in an orthodontic treatment group.

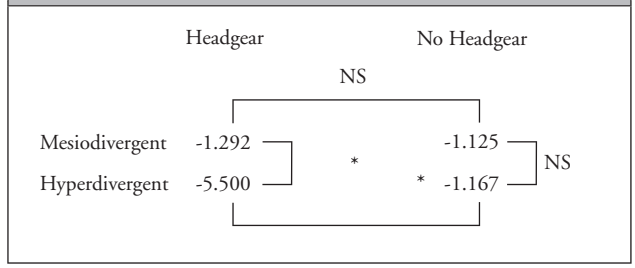
Facial height changes in this study and the other vertical changes concerning the lips and chin all increased without showing any significant difference between the groups. The vertical changes of S_n and A' values showed significant difference between the mesiodivergent and hyperdivergent groups. This seems to be due to the hyperdivergent growth pattern (Table 2). This is also valid for the $RL_x \perp A'$ value, showing a downward movement of A' where interaction was found to be significant (Table 5).

NASOLABIAL ANGLE

Nanda et al[24] and Genecov et al[25] observed that the nasolabial angle showed a tendency to decrease from age 7 to age 17, with no differences noted between the Class I and Class II samples.

Lo and Hunter[8] observed that the greater the maxillary incisor retraction, the greater was the increase in the nasolabial angle. The increase in the nasolabial angle showed a significant correlation with treatment-related increase in the lower face's vertical dimension. Bravo,[1] Drobocky and Smith,[5] Cummins et al,[28] and Ramos et al[29] found an increase in the nasolabial angle and retraction of the upper and lower lips with extraction therapy. Talass et al[3] reported that the clinically significant soft tissue changes in response to orthodontic treatment included the retraction of the upper lip and the increase in the nasolabial angle.

Table 5. Comparison of the Differences for $RL_x \perp A'$ Value Between Headgear Subgroups Within Mesiodivergent and Hyperdivergent Groups



**** P<0.05 NS Nonsignificant***

The nasolabial angle changes in the current study showed no significant differences between the groups (Table 2). The decrease in this angle seems to be associated with growth. The growth pattern or the use of headgear did not affect the change in this angle.

LABIOMENTAL ANGLE

Drobocky and Smith[5] noted a slight increase in the labiomental angle after orthodontic therapy, whereas Bravo1 found that there was almost no change. Bravo et al[30] observed more pronounced lower labial sulcus in those patients subjected to extraction. These observations agree with those reported by Young and Smith,[12] Luppanapornlarp and Johnston,[14] and Ramos et al.[29] Moesling and Woods[31] observed that upper and lower incisor positions and angulation of the face appear to play more significant roles in the behavior of the lower lip curve than the upper lip curve.

The increase in the labiomental angle in the mesiodivergent./headgear use group and the decrease of the labiomental angle in the hyperdivergent/headgear nonuse group were noted at the end of treatment. Comparison of the differences between the groups was not found to be statistically significant (Table 2). Nanda et al[24] found that the labiomental angle did not change by growth in males from 7 years to 18 years, but in females this angle decreased from 7 years to 18 years.

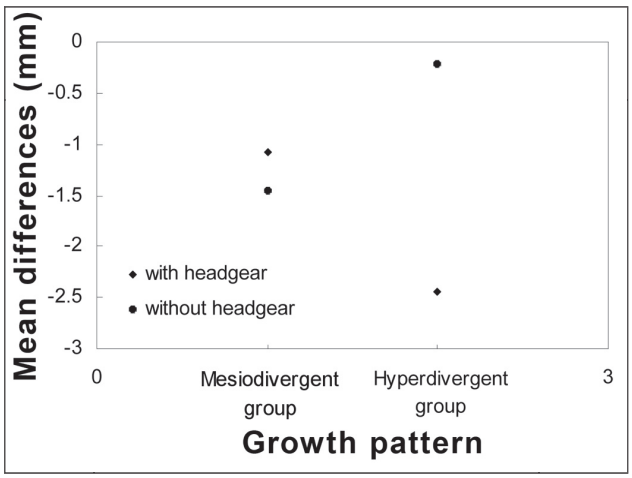


Figure 3. The mean values of Steiner lower lip (the differences and their significance are shown in Table 7).

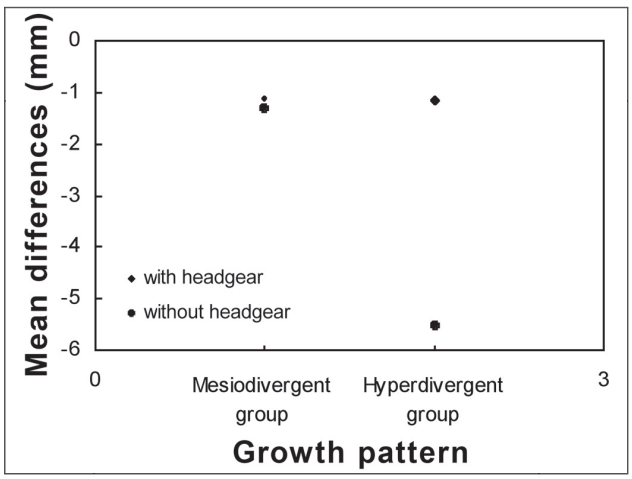


Figure 4. The mean values of $RL_x \perp A'$ (the differences and their significance are shown in Table 8).

CONCLUSIONS

Based on this study's results, the following conclusions can be made:

1. Avoiding premolar extraction, based on a possible significant detrimental effect on the face, is not justified.
2. Undesirable facial alterations in a patient are often not a result of orthodontic treatment, but a result of the subject's physiologic development.
3. Comparing mesiodivergent and hyperdivergent patients has shown that hyperdivergent patient profiles are exposed to excessive changes. Hence, use of headgear should be avoided in hyperdivergent patients, especially if the upper and lower lips are retruded at the beginning of treatment.

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