Original Article

Soft Tissue Changes after Upper Premolar Extraction in Class II Camouflage Therapy

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Abstract: The long-term effect on the facial profile has led many orthodontists to attempt Class II division I camouflage treatment without extraction. Practitioners may cite ''dishing in the face'' as a reason not to extract. Previous investigations have evaluated the soft tissue response after maxillary incisor retraction, but few have evaluated the effect of maximum retraction in skeletal mandibular deficient Class II patients with essentially no crowding. Twenty-seven Class II division I Caucasian patients with a mean of 8.62 mm of overjet, little to no arch length deficiency, and maximum anchorage requirements were treated with extraction of only maxillary first premolars. Pre- and posttreatment lateral cephalograms were taken. Using several skeletal and soft tissue cephalometric measures, the treatment changes were assessed. The mean maxillary incisor retraction was 5.27 mm, the mean maxillary lip retraction was 2.03 mm, and the mean mandibular lip retraction was 1.23 mm. All the patients finished with good overall facial harmony and balance. The maxillary first premolar extraction for orthodontic camouflage may be a viable treatment option, especially if the patient has full upper lips and only a relative mandibular deficiency. (*Angle Orthod* 2006;76:59–65.)

Key Words: Extraction; Soft tissue changes; Profile evaluation; Diagnosis and treatment planning

INTRODUCTION

Today's culture has an increased awareness and concern regarding facial esthetics. Orthodontic patients, their parents, and practitioners are concerned with the effect treatment may have on facial form and facial harmony. With this increased esthetic awareness, a trend toward nonextraction treatment has been observed with a growing use of ''molar distalization'' appliances.[1–4] This focus on nonextraction treatment demonstrates a greater focus on appliance choice, a choice that potentially may be at the expense of the functional and health aspects of orthodontic treatment.

In patients with moderate to severe Class II division I malocclusions, the chief complaint is typically an exaggerated horizontal overlap of the incisors. Patients and parents are routinely educated that although the intraarch tooth relationship position is satisfactory, a significant anterior-posterior skeletal discrepancy is present. Proffit[5] states that approximately 80% of Caucasian Class II patients display some degree of mandibular deficiency, whereas only approximately 20% express excessive maxillary development.

In the most severe Class II division I malocclusions, orthognathic surgery to advance the mandible is often indicated. With decreased insurance coverage for orthognathic surgery, the orthodontist may face a treatment-planning dilemma. If surgery is recommended and the patient either does not have insurance or the recommendation is not accepted by the patient, are other treatment options viable? Other potential treatment options include nonextraction molar distalization treatment, functional appliances, extraction of maxillary first premolars and mandibular second premolars, or extraction of only maxillary first premolars. Some patients may not be candidates for mandibular anterior repositioning appliances. For example, a dolichocephalic patient may show protrusive lower incisors, potential steepening of the occlusal plane and potential clockwise mandibular rotation result in an additional increase in facial height in an already long-face patient. The resulting question becomes, can extraction of maxillary first premolars be performed without neg-

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atively affecting the facial profile in patients who are not candidates for nonextraction functional appliance therapy?

A recent article by Mihalik et al[6] demonstrated that the occlusion obtained from premolar extractions for orthodontic camouflage in a Class II mandibular deficiency patient is stable. As a result, extraction of only maxillary premolars with the goal of finishing with Class II molars and Class I canines is a viable functional compromise.

Substantial previous research regarding the response of the soft tissue to tooth retraction has been performed, but few have examined cases with minimal arch length deficiency and maximum anterior retraction required. Even fewer have focused on patients who might benefit from surgical mandibular advancement but who opted to proceed with maxillary first premolar extraction. Burstone[7] has suggested that the way anchorage is managed, not the mere extraction of the teeth, determines the magnitude of anterior dental retraction and the resulting change in lip position.

The purpose of this investigation is to examine the effect of maxillary first premolar extraction in a homogeneous sample of full cusp Class II division I Caucasian patients who require only maxillary anterior retraction. In addition, a comparison of the results obtained will be discussed with regard to previous investigations of soft tissue response to orthodontic movement.[8–21]

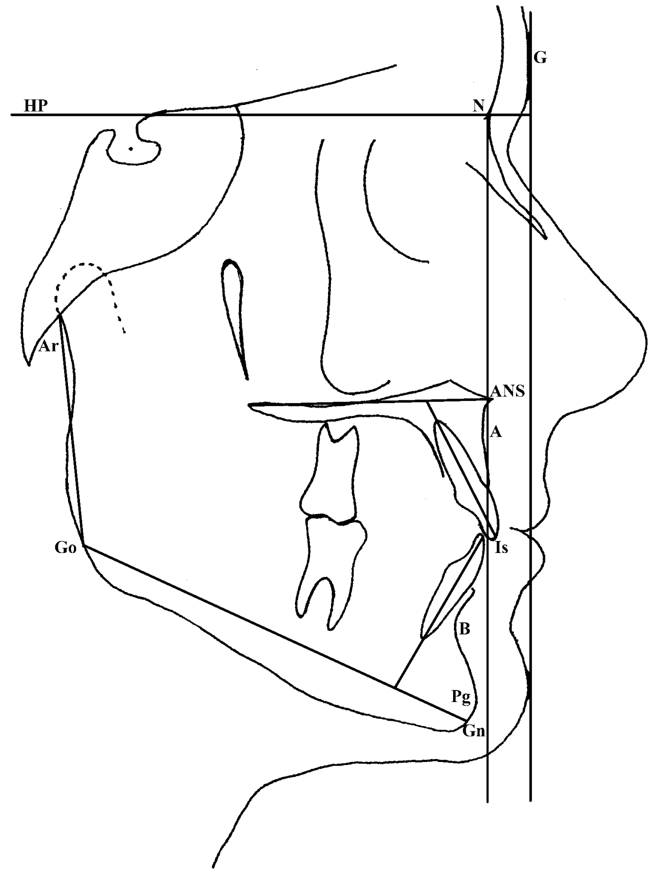

FIGURE 1. Skeletal cephalometric landmarks—please see Table 1 for description of the cephalometric landmarks.

MATERIALS AND METHODS

The subjects in this retrospective investigation were taken from the private practice of an ABO diplomat and the graduate orthodontic residency program at the Vanderbilt University Medical Center Division of Orthodontics. The inclusion criteria included a full cusp (molar/canine) Class II division I malocclusion, a minimum of five mm overjet, essentially no maxillary arch length deficiency, full fixed edgewise appliances, and extraction of only the right and left maxillary first premolars. All the patients were Caucasian with no previously extracted or missing teeth.

Both the pre- and posttreatment lateral cephalograms were taken at a constant magnification on the respective machines with lips in repose and in operator-assisted natural head position.[22] To account for the machine differences, the magnification for each machine was calculated. The small magnification differences were corrected by using a constant-conversion factor.

The posttreatment occlusion displayed a well-interdigitated Class II molar/Class I canine relationship with markedly reduced overjet. Twenty-seven patients (17 females and 10 males) with a mean age of 13.18 years (range 10–19 years of age) were available for evaluation. The mean pretreatment overjet was 8.6 mm, the pretreatment ANB angle was 5.5°, and the A-B to occlusal plane was −4.29 mm.

All the cephalometric radiographs were hand-traced on acetate paper and included the cranial base, nasal complex, maxilla, mandible, orbit, pterygomaxillary fissure, dentition, and the entire soft tissue profile from glabella to cervicale. When the central incisors overlapped, both were traced, and an average of the two axial inclinations was used. Facial balance, harmony, and esthetics were assessed using a standard clinical facial esthetic evaluation by both the resident and the faculty. The superimpositions were performed using the stable structures of the cranial base as described by Bjork from the longitudinal growth studies with metallic implants.[23] A sample tracing with the skeletal landmarks and reference planes used is shown in Figure 1. The soft tissue landmarks and reference planes are depicted in Figure 2. The definitions of the cephalometric landmarks and reference planes are listed in Table 1.

On the basis of Moorrees natural head position, a standardized horizontal reference plane was con-

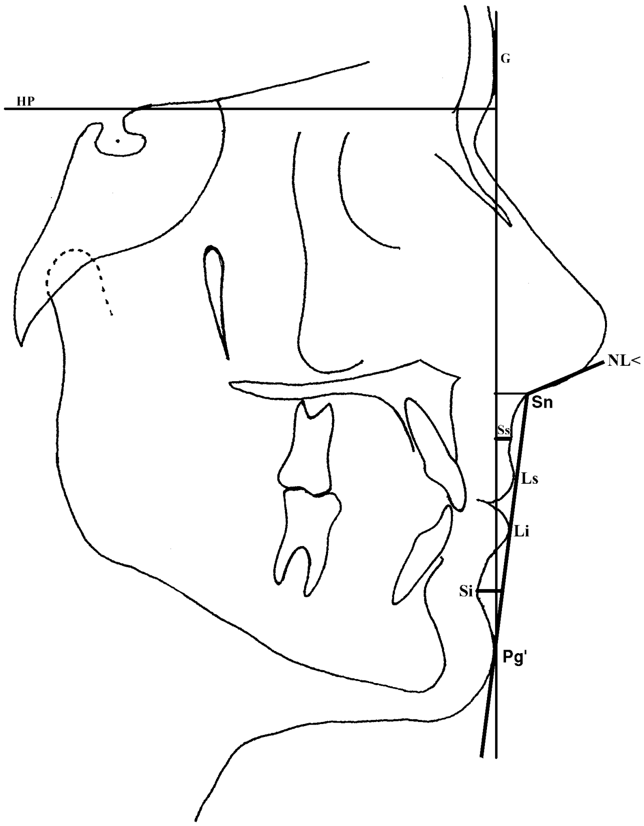

FIGURE 2. Soft tissue cephalometric landmarks—please see Table 1 for description of the cephalometric landmarks.

structed as SN + 7° for each patient. Nasion vertical and glabella vertical reference lines were drawn perpendicular to the natural head position (SN + 7°) line. Twenty-two cephalometric measurements were used, most taken from the COGS analysis (Cephalometrics for Orthognathic Surgery).[24] In addition, a line (Sn-Pg′) from the Legan and Burstone[25] soft tissue cephalometric analysis was used to describe several changes within the lower third of the face, particularly the changes in the lip projection. For consistency, the landmark Ss or sulcus superius was defined as the deepest point on the upper lip from subnasale to the vermilion border. To ensure landmark identification accuracy, tracing accuracy, and superimposition accuracy, cephalograms were randomly selected and traced by two separate graduate students in the third year of their orthodontic residency. These radiographs were traced by each resident and digitized into the QuickCeph 2000 software (San Diego, Calif). No significant interoperator differences were observed.

The data were analyzed with descriptive statistics. The mean and standard deviation for the pretreatment, posttreatment, and treatment changes were calculated. Treatment changes were assigned a negative (−) value if the landmark of interest moved posteriorly during treatment. A two-tailed student's *t*-test was computed to investigate the statistical significance of the treatment changes.

RESULTS

The mean pretreatment, posttreatment, and treatment changes along with the standard deviation and

TABLE 1. Cephalometric Landmarks and Reference Planes

Measure	Definition
N-A	The anteroposterior distance of A-point (subspinale) to nasion vertical
N-B	The A-P distance of B-point (supramentale) to nasion vertical
N-Pg	The A-P distance of pogonion to nasion vertical
ANS-Gn	The vertical distance from the anterior nasal spine (ANS) to anatomic gnathion (perpendicular to horizontal plane)
MP-HP	The angle formed between the mandibular plane (Go-Me) and the horizontal plane
Ar-Go-Gn	The gonial angle
1-NF	The inner angle formed by the long axis of the most prominent incisor and the palatal plane or nasal floor
1-MP	The inner angle formed from the long axis of the most prominent incisor and the mandibular plane (Go-Me)
A-B (//OP)	The perpendicular projection of B-point and A-point to the functional occlusal plane (−) if B is posterior to A
G-Sn	The A-P distance of subnasale to glabella vertical
G-Pg′	The A-P distance of soft tissue pogonion to glabella vertical
NL<	The nasolabial angle formed by the philtrum and collumella
Ls (Sn-Pg′)	The distance from labrale superius to the Burstone esthetic plane: Sn-Pg′
Li (Sn-Pg′)	The distance from labrale inferius to the Burstone esthetic plane: Sn-Pg′
Si (Li-Pg)	The distance of the deepest point in the labiomental fold to the Li-Pg′ plane
G-SS	The perpendicular distance from the superior sulcus to glabella vertical
G-Ls	The perpendicular distance of labrale superius to glabella vertical
G-Is	The perpendicular distance of the incisal tip to glabella vertical
Overjet	The millimetric measurement from lower to upper incisal tip
ANB<	The sagittal skeletal discrepancy angle, A-point to Nasion to B-point
A-SS	The linear distance from A-point to philtrum (// to HP)

TABLE 2. Pre- and Posttreatment Cephalometric Measures and the Treatment Changes[a]

Ceph. Measure	Pre Mean	Pre SD	Post Mean	Post SD	Treatment Change Mean	Treatment Change SD	*t*-test
Apical base							
N-A (mm)	−0.63	3.10	−2.58	3.05	−1.94	1.90	$P < .001$***
N-B (mm)	−9.19	5.09	−9.69	6.17	−0.50	3.30	NS
N-Pg (mm)	−7.69	6.47	−7.73	7.87	−0.04	4.15	NS
A-B (//OP) (mm)	−4.29	2.57	−1.79	2.39	2.50	2.90	$P < .001$***
ANB< (°)	5.54	1.96	3.54	1.36	−2.00	1.96	$P < .001$***
Facial height							
ANS-Gn (mm)	60.42	5.74	64.88	6.15	4.46	3.17	$P < .001$***
MP-HP (°)	22.90	4.50	24.13	5.22	1.23	3.13	NS
Ar-Go-Gn (°)	122.67	4.63	122.81	4.81	0.13	1.40	NS
Dental measures							
1-NF (°)	113.94	8.16	108.42	5.25	−5.52	7.82	$P < .001$***
G-Is (mm)	−4.75	5.16	−10.02	5.60	−5.27	3.54	$P < .001$***
1-MP (°)	94.67	5.16	95.33	5.04	0.65	5.82	NS
Overjet (mm)	8.62	2.41	2.96	0.60	−5.65	2.64	$P < .001$***
Soft tissue form							
NL< (°)	118.42	11.32	124.81	11.28	6.38	7.47	$P < .001$***
G-Sn (mm)	5.85	4.75	5.60	4.86	−0.25	2.86	NS
G-Ss (mm)	5.90	4.63	4.63	5.24	−1.27	2.83	$P < .05$*
A-Ss (mm)	15.98	2.56	15.81	2.23	−0.17	2.03	NS
G-Ls (mm)	7.55	4.96	5.52	5.20	−2.03	2.94	$P < .05$*
Ls (Sn-Pg′) (mm)	4.48	1.50	2.58	1.84	−1.90	1.41	$P < .001$***
Li (Sn-Pg′) (mm)	2.71	2.18	1.48	2.55	−1.23	2.17	$P < .01$**
Si (Li-Pg′) (mm)	−7.13	1.56	−5.40	1.98	1.73	1.78	$P < .001$*
G-Pg′ (mm)	−4.08	6.91	−3.58	8.69	0.50	4.39	NS

[a] NS indicates not significant; Ceph., cephalometric.
* $P < .05$, ** $P < .01$, *** $P < .001$.

student's *t*-test results are shown in Table 2. Significant soft tissue treatment effects were shown in the nasolabial angle, which increased 6.38 from a pretreatment of 118.42 to a posttreatment of 124.81. In addition, the upper lip projection (G-Ls) decreased 2.03 mm. Relative to the Sn-Pg′ line, labrale superius decreased 1.90 mm, whereas labrale inferius decreased 1.23 mm.

Skeletal treatment effects were observed more in the maxilla and maxillary dentition than in the mandible or mandibular dentition. A-point (measured from nasion vertical) moved posteriorly 1.94 mm. Incisor superius retracted 5.27 mm, and the upper incisor angulation (1-NF) uprighted 5.5°. The overjet was significantly reduced 5.65 mm ($P < .001$), whereas the mandibular incisor angulation (1-MP) only changed 0.65°. The interarch relationship improved significantly as well with the ANB angle decreasing two degrees ($P < .001$) and the A-B to occlusal plane relationship improving 2.50 mm ($P < .001$). Vertically, there was a mild increase in the lower face height (ANS-Gn) of 4.46 mm.

There were no significant changes in supramentale, mandibular plane angle, or pogonion. There were also no significant changes in subnasale or the gonial angle relative to glabella vertical (G-Sn). Finally, the lower incisor angulation (1-MP) did not change significantly during treatment ($P = .57$).

TABLE 3. Ratio of Maxillary Incisal Retraction to Soft Tissue Retraction

Ratio	Mean	SD	*r*
Is/Sn	2.93	3.79	0.55
Is/Ss	4.15	2.58	0.73
Is/Ls (Gv)	2.6	3.89	0.75

Ratios of incisor movement and its effect on the overlying soft tissue were also calculated (Table 3). The ratio, standard deviation, and correlation coefficient are listed. To produce a one mm decrease in projection at subnasale, the incisors had to be retracted 2.93 mm. To produce a one mm decrease in projection at the superior sulcus, the incisors had to be retracted 4.15 mm. Finally, to produce a one mm change in labrale superius projection, the incisors had to be retracted 2.6 mm.

DISCUSSION

A mean increase in the nasolabial angle of 6.38° was observed, which shows a similar direction of movement as other evaluating changes resulting from tooth extraction. However, this study group displayed greater nasolabial angle change than previous studies. The increased change observed in this study is most likely because of the strict retraction requirements of this patient sample and the larger mean maxillary incisor retraction than the previous studies. A greater retraction of the incisors gives more opportunity for the soft tissue between subnasale and labrale superius to move posteriorly. The nasolabial angle is made up of both the soft tissue (pronasale) and the cartilaginous (columella) portions of the nose, which continues to grow forward, as well the soft tissue of the upper lip. Table 2 demonstrates that only a small and statistically insignificant amount of retraction occurred in the nasal base (subnasale). If the upper lip projection is decreasing while nasal base projection remains the same, the nasolabial angle must become more obtuse.

The upper lip did not respond uniformly to the retraction of the upper incisors. Table 2 shows subnasale projection had no significant change, whereas the superior sulcus projection decreased 1.27 mm and labrale superius projection decreased 2.03 mm relative to glabella vertical and 1.90 mm relative to the Sn-Pg′ plane. The differential in movement shows not only a decreased bodily projection of the lip but also a trend toward a straight upper lip rather than a concave upper lip. This trend toward a straighter upper lip is denoted as a decreased ‘‘lip curl.’’

Some have postulated that even with extraction of teeth and the subsequent orthodontic retraction, the lips may come forward because of growth of the maxilla. In this patient pool none of the patients experienced any net forward movement of the lip relative to the Sn-Pg′ line. The most limited change involved three patients who had no net change in lip position relative to the Sn-Pg′ line. However, relative to the glabella vertical, two patients did have an increase in the lip projection and two patients showed no net lip retraction. Forward movement of the lips would be more likely to occur in an individual with crowding and retroclined maxillary incisors rather than individuals with essentially no crowding and proclined incisors.

The more regional effect of the incisor retraction should be expected because even with orthognathic surgery, the soft tissue change decreases as the distance from the surgical site increases. The mean pretreatment position of incisor superius to the glabella vertical reference line in the patients studied was −4.75 mm. The posttreatment mean incisor position to the vertical reference plane was −10.02 mm. This was a highly significant change of 5.27 ($P < .001$). The mean overjet reduction was 5.65 mm, which was also highly significant ($P < .001$). This shows approximately a 1:1 relationship between maxillary incisor retraction and overjet reduction indicating that the overjet reduction came primarily from the upper incisor retraction rather than proclination of the lower incisors.

The decreased upper lip projection and decrease in lip curl is typically cited as a reason not to extract. In this sample, although the highly significant maxillary incisor retraction of 5.27 mm occurred, labrale superius only changed 2.03 mm relative to the glabella vertical and 1.90 mm relative to the Sn-Pg′ line. Although statistically significant, patients' parents, the lay public, and even orthodontists may have a difficult time observing a two-mm lip change with all the other craniofacial changes occurring at the same time because of growth, development, and continued patient maturation. In addition, patients with a large overjet treated with extraction for orthodontic camouflage have cited overall satisfaction with their treatment results.[6]

Other positive findings that should be communicated to patients are that if less overjet, more arch length deficiency, and lesser anchorage requirements are present, they should expect much smaller profile changes than those illustrated in this study. As a result, a patient with a less severe Class II division I malocclusion (3.5 mm Class II with moderate to severe crowding) should not be nearly as concerned about the potential for decreased lip projection. In fact, patients with canines blocked out of the arch and a severe full cusp Class II relationship, who undergo extraction of maxillary first premolars, may experience either no change or even an increased lip projection rather than decreased lip projection. The only time greater lip retraction than the results of this study displayed might result from extraction of maxillary first premolars and performing a surgical anterior maxillary setback. This surgery was first attempted in the late 1970s and early 1980s but was quickly abandoned because of the high number of unesthetic results.

One slightly unexpected result may have been the decrease in the lower lip projection. Typically, one does not expect to see a decrease in lower lip projection if lower teeth are not extracted. This decrease most likely resulted from an uprighting of the lower lip. This particular group of patients tended to have a deep labiomental fold indicative of an everted lower lip. With a deep overbite, an increased overjet, and a Class II dental relationship, the lower lip may be artificially held in a more forward position trapped in the space between the upper and the lower incisors. As the bite opens and the maxillary incisors are retracted, the lip returns its normal position resulting in a ‘‘decreased’’ lower lip projection. This is not a true decrease but a removal of an occlusal interference, which prevented the lower lip from being in true approximation relative to the mandibular incisors all along. This also explains the decrease of the labiomental fold of 1.73 mm that was observed.

One final concern is the potential for decreased chin projection. With the bite opening that occurred (ANS-Gn increased 4.46 mm), it is possible to see a downward and backward rotation of the chin. The potential exists, but in this patient pool the mandibular plane displayed a change that was not significant. The remaining minimal mandibular growth was sufficient to overcome the mild increase in face height, without reducing the chin projection. This increase most likely results from unavoidable orthodontic extrusive mechanics as well as normal craniofacial growth and development.

In addition to the absolute changes that were observed, three ratios were calculated to determine the average effect the maxillary incisor retraction had on the soft tissue of the upper lip from subnasale to labrale superius. The maxillary incisors had to be retracted 2.93 mm before a one mm decrease in subnasale projection could be observed. The maxillary incisors had to be retracted 4.15 mm to achieve a one mm decrease in superior sulcus projection. Finally, the maxillary incisors had to be retracted 2.6 mm to observe a one mm change in labrale superius projection.

One shortcoming of this investigation may have been the lack of evaluating changes in the maxillary first molar position. There is no account of the potential anchorage loss. In this sample of growing patients, there may have been a loss of anchorage that was made up by mandibular growth. The result would make it difficult to determine the true anchorage loss of the maxillary buccal segments because the Class II molar relationship was maintained. A control group would have been beneficial as well, but none of the patients elected to defer treatment until a later time; however, a previous article does describe limited changes in the soft tissue profile because of growth in a 36-month or less treatment period.[26] In addition, the use of Class II elastics, which were required, may have overcome temporary anchorage loss by advancement of the mandibular dentoalveolar complex and tipping of the occlusal plane to accommodate a favorable change in sagittal apical base discrepancy (A-B//OP). A vertical measurement of the molar position from a cranial base perpendicular could aid in the evaluation of the increased facial height. The increase may have been not only because of lower molar eruption from the Class II elastics but also because of maxillary molar eruption due to growth and or extrusion during the incisal retraction.

CONCLUSIONS

- Maximum anchorage required orthodontic camouflage and the soft tissue response was larger; yet, a balanced profile was produced.
- Most notably, labrale superius and labrale inferius were retracted, the lower facial height increased mildly, and the nasolabial angle became more obtuse.
- Maxillary incisor retraction to labrale superius retraction occurred at a 2.68:1 ratio.
- The overall trend did display a mild reduction of the profile with concomitant mild lengthening of the lower third of the face.
- Informing the patient of the possibility of profile reduction with extractions should be performed.
- The decreased lip projection is much less than the amount of incisor retraction.
- This group of patients represents the largest possible change resulting from only orthodontic treatment, and most patients will present with less severe malocclusions. With more crowding, the change in lip projection will be less making the extraction of maxillary premolars a viable functional and esthetic treatment option.
- In patients with full lips and only relative mandibular deficiency, the decreased projection can be a desirable treatment goal.

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