Evaluation of lip response to incisor retraction in various growth patterns

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Abstract

Aims and Objectives: To evaluate the response of the lips and to determine if there are any differences in the response following first premolar extractions and subsequent incisor retraction in vertical, average, and horizontal growth patterns. **Materials and Methods**: The soft tissue changes after the extraction of maxillary and mandibular first premolars and anterior retraction were evaluated for 60 Class I malocclusion patients. The sample was divided into three groups namely patients with vertical average and horizontal growth patterns. They were digitized and analyzed for changes in the integumental profile with treatment following premolar extraction. **Results**: The upper lip retraction for the vertical growth pattern was 1.4:1 while in the average and horizontal growth patterns it was 1.8:1 and 2.2:1. The lower lip retraction was 1.1:1, .1.3:1 and .1.7:1 for the three growth patterns. **Conclusion:** Lip response to retraction differed in the three growth patterns.

Keywords: growth patterns, lip response.

Introduction:

Orthodontists have long realized that changes in the facial profile are often coincident with therapy instituted to correct a malocclusion.[1,2] To obtain stability of the attained orthodontic results, a balance between the dental and perioral muscles must be achieved. The soft tissue covering of the face also plays an important role in facial esthetics, speech, and other physiologic functions. These potential changes in the soft-tissue contour of the facial profile have been thought to be important considerations in the development of a treatment plan for the individual patient. Accurate prediction of changes that may occur with differing therapeutic modes could facilitate the selection of a treatment plan that best fulfills the treatment objectives for the individual. Soft-tissue predictions have been based on ratios of mean soft-tissue movement to the movement of corresponding hard-tissue points.[3-17] Most authors have concluded that accurate predictions of individual soft-tissue changes could not be made because of wide variation in the responses of the soft tissues to tooth and alveolar process changes.[6,14,16,18-22]

However, the nature of correlation between incisor retraction and lip adaptation is still controversial. Thus, controversy still exists as to the ability of an orthodontist to predict soft tissue changes at the time treatment is planned for a patient. One parameter which has not been

studied in the response of the lips to incisor retraction is the growth pattern. There is considerable evidence showing smaller, less active, muscles and weaker bite forces among hyperdivergent subjects. Horizontal growth patterns feature includes thin lips, deep mentalis sulcus and strong muscle while vertical growth pattern is associated with weak musculature. [23] Hence the aim of this study was to evaluate the response of the upper and lower lips and to determine if there are any differences in the response following first premolar extractions and subsequent incisor retraction in horizontal, average, and vertical growth patterns.

Materials and Methods.

Records of 60 orthodontic patients, who had their 4 first premolars extracted, were obtained. The selection criteria for those patients were as follows:

1. Similar ethnic group with a Class I malocclusion and skeletal bimaxillary protrusion

2. A minimum age at the beginning of treatment of 18 years to reduce growth effects. Further, the lateral cephalogram series should show no significant facial growth through the time period studied to avoid confounding variables of facial growth. No patient should exhibit more than 1 mm change in the horizontal position of pogonion or the vertical position of menton during the treatment period. The mean age of the three groups were identical at the start of treatment.

3. Availability of a good quality pretreatment lateral cephalogram taken immediately before the active orthodontic treatment started and a posttreatment lateral cephalogram taken immediately after active orthodontic treatment ceased. The cephalograms should show a relaxed lip posture.

4. All patients who accepted extraction treatment for profile reduction and fulfilled the other selection criteria were included in this study.

5. All patients were treated by 1 operator who planned to reduce lip fullness by using continuous maxillary and mandibular preadjusted 0.022 slot MBT prescription pre edgewise appliances with sliding mechanics and no extraoral anchorage.

6. Mandibular plane angles of Downs and Steiner and Y axis were used to classify the patients into the three growth patterns.

In the present study, several variables which have affected the results of other studies were minimized. Our study used only female patients who were past adolescence at the start of treatment. All patients were treated according to a carefully executed treatment plan.

Both pretreatment and posttreatment lateral cephalograms were taken in a natural head position with the lips relaxed. Each lateral cephalogram was traced and a reference line was established, 7 degrees down from SN through S. A perpendicular to this line was utilized as the vertical

reference line. (Figure 1). Twenty five linear measurements and five angular measurements were utilized. (Figure 2a and b)

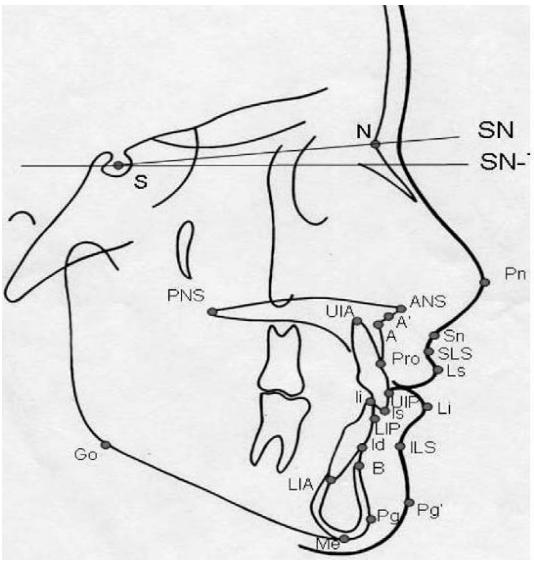

Figure 1: Landmarks

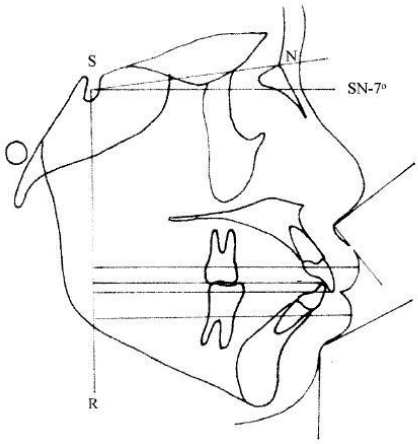

Figure 2a: Measurements

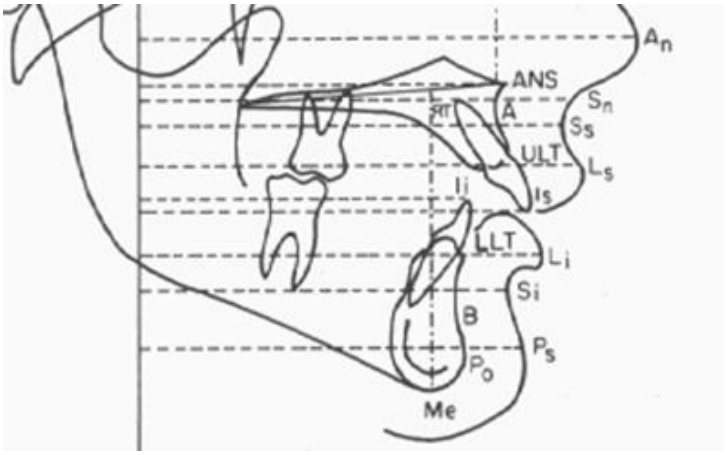

Figure 2b: Measurements

Cephalometric Procedures and Measurements

All pretreatment (T1) and posttreatment (T2) cephalograms were digitized by the primary investigator using Dolphin imaging software. The horizontal reference plane was registered on sella (S) and oriented 7 degrees inferior to the sella nasion (S-N) line.

The following skeletal, dental, and soft-tissue landmarks were identified for the study (Figures 2 a and b)

Skeletal.

Sella (S)— Center of the contour of sella turcica.

Nasion (N)— Most anterior point of the nasofrontal suture in the midsagittal plane.

Point A (A)— Deepest point in the midsagittal plane between the anterior nasal spine and prosthion.

Point B (B)— The deepest point in the midsagittal plane between infradentale and pogonion.

Soft tissue:

Subnasal (Sn)— The point of convergence of the nose and the upper lip.

Superior sulcus (SS)— The point of greatest concavity in the midline between the upper lip (Ls) and subnasale (Sn).

Upper incisor point (UIA)— The most anterior point on the crown of the upper incisor.

Labrale superius (LS)— The most anterior point on the convexity of the upper lip.

Lower incisor point (LIA)— The most anterior point on the crown of the lower incisor.

Labrale inferius (LI)— The most anterior point on the convexity of the lower lip.

Sulcus inferius (SI)— The point of greatest concavity in the midline between the lower lip and soft-tissue chin.

Soft-tissue pogonion (Pg')— The most anterior point of the soft-tissue chin.

Stomion superius (Stms)— The lowermost point of the upper lip.

Stomion inferius (Stmi)— The uppermost point on the vermilion border of the lower lip.

Statistical Analyses

The SPSS (SPSS Inc, Chicago, Ill) was used for the statistical evaluations. Mean changes occurring during treatment were then calculated, and the data were statistically analyzed. Pre and Post treatment comparisons were done using the paired t test. Pearson's correlation coefficients and associated levels of significance were calculated to search for significant correlations among all variables. A p value of .05 was considered significant.

Results

Means and changes in angular and linear variables for the three groups are shown in Table 1. Mean treatment changes for both groups were similar and included upper incisor retraction,

increase in the nasolabial and labiomental angles and a reduction in the thickness of the lips. The upper lip retraction for the vertical growth pattern was 1.4:1 while in the average and horizontal growth patterns it was 1.8:1 and 2.2:1. The lower lip retraction was 1.1:1, .1.3:1 and 1.7:1 for the three growth patterns.

Table 1

Linear Parameters difference between T1 and T2 (millimeters)	Horizontal growth pattern (Mean ±SD)	Average growth pattern Post (Mean ± SD)	Vertical Growth Pattern ((Mean ± SD)
1. A' – SNV (Retraction of upper lip at Point A)	2.6±.2	2.5±.3	2.4±.2
2. B'-SNV (Retraction of upper lip at Point B)	1.8±.3	1.9±.3	2.2±.3
3. Ls-SNV (upper lip retraction)	2.1 ±.3	2.3 ±.3	2.9±.2
4. Li-SNV (lower lip retraction)	2.3±.2	2.5±.3	2.7±.5
5. Ls-UI anterior most (upper lip thickness)	-.5±.5	-.5±.3	-.6±.5
6. Ls-UI tip (upper lip thickness)	-.5±.5	-.5±.3	-.6±.5
7. Li-LI Anterior most (lower lip thickness)	-.5±.3	-.5±.3	-.5±.7
8. Li-L1tip (lower lip thickness)	-.5±.5	-.5±.5	-5±.5
9. A-A' (Lip thickness)	-.5±.3	-.7±.3	-.8±.3
10. LS – Prosthion (Upper Lip thickness)	-.4±.7	-.5±.6	-.7±.5
11. Lip strain	-1.1±.4	-1.1±.6	-1.4±.4
12. Li –CEJ L1 (Lip thickness)	-.4±.7	-.5±.6	-.7±.5
13. B –Si (Lip thickness)	-.4±.7	-.5±.6	-.7±.5
14. ANS-Sn (upper lip thickness)	-.4±.7	-.5±.6	-.7±.5
15. Sn- a (Basic upper lip thickness)	-.4±.7	-.5±.6	-.7±.5
16. (Upper lip taper)	-1.1±.4	-1.1±.6	-1.4±.4
17. B- B' (Basic lower lip thickness)	-.4±.7	-.5±.6	-.7±.5
18. (Lower lip taper)	-1.1±.4	-1.1±.6	-1.4±.4

19. Sn-Stm S (Upper lip length)	.7±.3	.5±.3	.9±5
20. Sn – Stm i (Lower lip Length)	.4±.7	.5±.6	.7±.5
21. Si-pog' (Vertical lower lip length)	1.1±.4	1.1±.6	1.4±.4
22. U1Anterior most-SNV (retraction of the anterior most point on the upper incisor)	3.6 ± .6	3.7±.5	3.7±.7
23. L1Am-SNV(retraction of the anterior most point on the lower incisor)	3.1 ± .6	3.1±.5	3.0±.7
24. U1tip-SNV(retraction of the upper incisor tip)	4.3 ± .6	4.2±.5	4.1±.7
25. L1tip-SNV(retraction of the lower incisor tip)	3.9 ± .6	3.8±.5	3.8±.7
Angular Parameters difference between T1 and T2 (in degrees)			
1. Nasolabial angle	-5.2±1.4	-6.1±1.2	-7.3±1.5
2. Labiomental angle	-4.2±1.9	-5.5.1±1.9	-6.2±.9
3. MPA	1.2±.6	1.1±1.2	2.3±1.5
4. U1 –SN7	-5.7±1.5	-6.3±1.5	-7.3±1.8
5. L1-MP	5.4±1.4	6.1±.5	6.6±1.2

Discussion

Accurate prediction of changes in the soft tissue profile after orthodontic treatment is desired. The findings of this study can be used as a source of quantitative information for the orthodontist, the patient, and the patient's family about profile changes that may occur as a result of orthodontic treatment. When treating malocclusions with bimaxillary protrusion, it is assumed that the upper and lower lips will move back, while the nasolabial and labiomental angles increase as a result of the orthodontic retraction of the maxillary and mandibular incisors. In this study, significant posterior movement of the upper and lower lips occurred with simultaneous significant increases of the nasolabial and labiomental angles.

Nasolabial and lip angle

Although incisor retraction and corresponding lip movement differed somewhat between the groups the values were not statistically significant. The present results support the simple expectation that incisor retraction will result in a larger final nasolabial and lip angle. When the

upper lip follows the incisors, it pulls the subnasale areas forward and downward slightly, causing an increase in the slope of the lower nasal border. According to Subtelny [24] as the nose grows the lower border tends to tip forward and downward slightly which may decrease the nasolabial angle.

Thickness of the upper lip (A-A')

Talass et al, [25] Chiavini,[26] and Ricketts [13] reported increase in upper lip thickness because of retraction of the maxillary incisor. These three studies used the labial face of the incisor and point Ls as points of reference. Lamastra [9] reported a slightly greater decrease in lip thickness when the labial groove was retracted by one mm. Hershey [6] described 0.71 mm reduction with one mm of retraction.

Upper lip movement related to incisor retraction.

Upper lip retraction was significantly correlated with maxillary incisor retraction, Typically, the incisal edge or the most vestibular point of the incisor has been the most common landmark selected, but this point has minimal predictive value for lip movement .[25-27]Hershey [6] reported a higher determination (64%) when he used the most labial point of the incisor crown.

The tip of the upper incisor showed better associations with upper lip retraction than prosthion. Higher associations for prosthion have been previously identified.[28,29] They stated that the region above the crown may be expected to be more predictive than the crown because it incorporates information about both the crown and overlying bony support. This is important because most studies only consider the facial surface or the tip of the upper incisor when predicting soft tissue changes. [6,12,14,25,28 -35].

The soft-to-hard tissue relationships were consistently stronger for the lower than for the upper lip. Correlations for labrale inferioris were similar to those previously reported. [14-32,33,37] This finding reinforces the notion that the complex anatomy of the nose influences the upper lip and may contribute to its weaker relationships with the underlying hard tissues.

In agreement with Rains and Nanda, [12] this study showed that the length of the lower lip increased with orthodontic treatment. The 0.6 mm of average increase in the lower lip length reported by Rains and Nanda[12] was more or less like that reported in this study.

Comparisons across studies are difficult due to methodological differences. Monahan[10] found the correlation between upper incisor retraction and upper lip change to be improved in a subsample of high mandibular plane angle patients. Stromboni [38] concluded that in skeletal open bite cases extraction therapy resulted in better lip contour because of a smaller increase in anterior facial height than in non-extraction treatment.

Despite the fact that it has previously been accepted that considerable upper lip retraction will necessarily follow upper incisor retraction,[39-43]it is now widely recognized that the complex functional musculoskeletal anatomy of the nose/upper lip complex contributes to the observed wide variability of upper lip change with premolar extraction treatment.[6,14, ,21, 35]

Simplistic ratios of lip response to upper incisor movement would therefore seem to be of limited value for application to treatment planning in individual subjects. It seems that the lips may be affected by anteroposterior tooth movements, but the degree to which this occurs is likely to be variable, depending on the treatment mechanics used, the various extraction or nonextraction decisions, the final angulations of the upper and lower incisors and the pretreatment lip thickness. But the underlying vertical and anteroposterior facial patterns may account for the wide variations seen in the ratios reported by various studies.

Many variables were eliminated from this study. The role of growth was eliminated by taking adult patients and if there was residual growth, it would have been common for the three groups. Gender differences were also eliminated by incorporating only females. Treatment mechanics and the sagittal malocclusion were also streamlined. But, individual variation in the growth of the nose and chin and the direction of overall facial growth make it difficult, if not impossible, to accurately predict changes in the nasolabial angle and lip curve depths for growing patients.

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