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Soft tissue changes associated with first premolar extractions in adult females

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Background: The potential for premolar extractions to produce changes in the soft tissue profile after orthodontic treatment is controversial.
Aim: To evaluate the soft tissue changes associated with four first premolar extractions in adult females of South Indian ethnicity.
Method: Pre- and post-treatment lateral cephalometric radiographs of 30 adult female patients of South Indian ethnicity with bimaxillary dentoalveolar protrusion, requiring premolar extractions as a part of their orthodontic treatment, were used.
The radiographs were traced and changes in three angular and 12 linear measurements measured relative to the perpendicular to the horizontal reference line, 7 degrees down from S-N through S. Correlation coefficients between the changes in the upper and lower incisors and the lip measurements were calculated.
Results: All linear and angular measurements, except for changes in upper and lower lip thickness, B' point and the anterior point on the lower lip, showed statistically significant ($p < 0.05$) changes with treatment. A significant negative correlation was found between upper incisor change and nasolabial angle change and a significant positive correlation was found between upper incisor change and retraction of the most anterior point on the upper lip.
Conclusion: Extraction of the four first premolars followed by the retraction of incisors reduced the dental and soft tissue protrusion found in adult South Indian females with bimaxillary dentoalveolar protrusion.
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Introduction

Pleasing facial aesthetics are a primary objective of contemporary orthodontic treatment. Facial aesthetics are influenced by the morphology of the facial skeleton and the response of the overlying soft tissues to the position and form of the facial skeleton. The forms of the facial hard and soft tissues differ significantly among various ethnic groups and, hence, norms acceptable for one group may not be acceptable for another.

An aesthetic lip profile is an important feature of a well-balanced facial profile. Different methods of assessing lip protrusion have been reported: one of the most commonly used reference planes is the E-line (the line extending from the tip of the nose to the anterior most point on the chin) introduced by Ricketts.[1] Burstone proposed the Sn-Pg line to overcome variability of the nose,[2] and others have made use of different angles using the chin and the lips as reference points e.g. z-angle, Holdaway angle.[3,4]

Bimaxillary dentoalveolar protrusion is a condition characterised by protrusive and proclined upper and lower incisors, which often part the lips, and an increased prominence of the lips.[5] Favourable soft tissue changes and successful orthodontic correction of bimaxillary protrusion have been reported following treatment which includes extraction of the four first premolars.[5–7] Orthodontists have long recognised that extraction of premolars is often accompanied by changes in the soft tissue profile. Although many studies have evaluated the relationships between incisor movement and soft tissue profile changes,[8–11]

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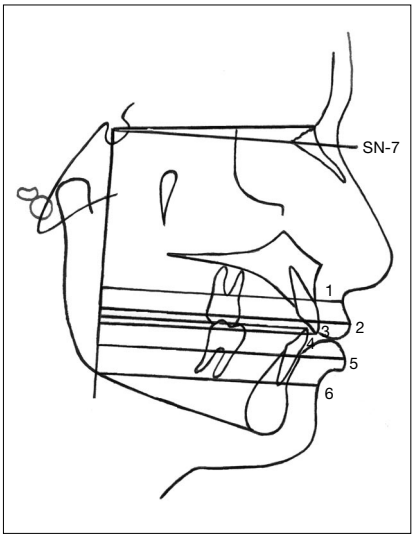


Figure 1. Linear measurements to the vertical reference line. 1, A' point; 2, Anterior most point of upper lip; 3, Upper incisor tip; 4, Lower incisor tip; 5, Anterior most point on lower lip; 6, B' point.

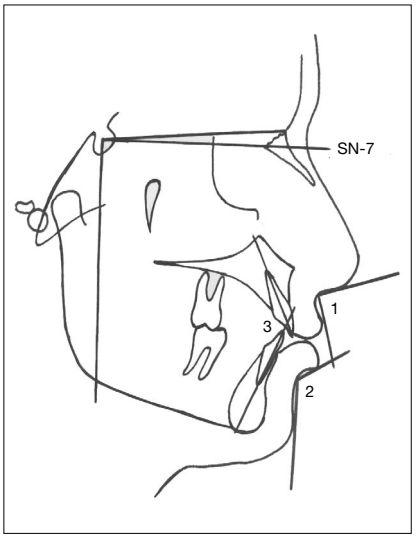


Figure 2. Angular measurements. 1, Nasolabial angle; 2, Labiomental angle; 3, Inter-incisal angle.

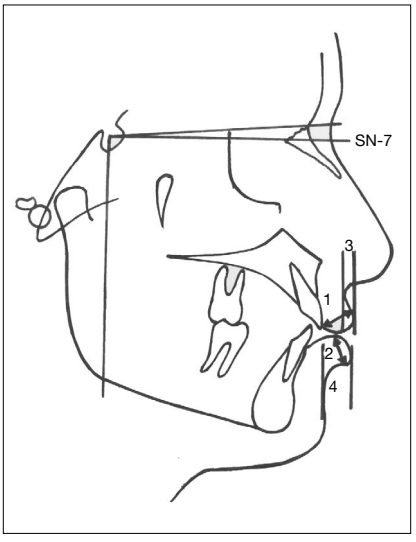


Figure 3. Vertical measurements. 1, Upper lip thickness; 2, Lower lip thickness; 3, Upper lip depth; 4, Lower lip depth.

there is surprisingly little information directly connecting the magnitude of the soft tissue changes during premolar extraction treatment and the desirability of these changes.[12]

According to Oliver,[11] there are differing views on the influence of premolar extractions and retraction of the incisors on the soft tissue envelope of the face. Some researchers have found high correlations between incisor retraction and upper lip retraction, suggesting a close relationship between the soft tissues and underlying hard tissues,[13,14] while others have reported that changes in the soft tissues do not necessarily follow the changes in the dentition.[1,10,15]

This retrospective study examines the effects of first premolar extractions and incisor retraction on the lips of adult South Indian women with bimaxillary protrusion. Due to the relatively high prevalence of bimaxillary protrusion in this particular ethnic group and the lack of baseline data, the findings from this study may be of great interest to orthodontists in South India. Our objectives were two-fold: to determine the effects of upper and lower incisor retraction on the soft tissue profiles of adult females with bimaxillary protrusion and to report significant ratios between the hard and soft tissue parameters.

Materials and methods

The pre- and post-treatment lateral cephalometric radiographs of 30 adult female orthodontic patients were randomly selected from the files in the Department of Orthodontics and Dentofacial Orthopaedics, College of Dental Sciences, Karnataka. The selection criteria were as follows: adult females with bimaxillary dentoalveolar protrusion; the four first premolars had been extracted as part of their orthodontic treatment; subjects were from the local South Indian population.[16]

At the start of treatment the mean age of the sample was 18.2 ± 1.2 years and the mean mandibular plane angle was 29.2 ± 1.6 degrees. The subjects were treated for 19.6 ± 2.6 months by postgraduate students in the Department of Orthodontics and Dentofacial Orthopaedics using a 0.022 inch slot pre-adjusted edgewise appliance. Pretreatment and post-treatment lateral cephalometric radiographs were taken in natural head position with the lips in the relaxed position. Each lateral cephalometric radiograph was traced and a horizontal reference line constructed, 7 degrees down from S-N through S. The perpendicular to this line served as the vertical reference line. Linear measurements were made with a millimetre rule from soft tissue A (A') point, upper incisor tip, lower incisor tip, most anterior point of upper lip, most anterior point of lower lip and soft tissue B (B') point to vertical reference line (Figure 1). The nasolabial angle, interincisor angle and labiomental angle were also measured (Figure 2). Upper and lower lip curve depths were measured

Table I. Comparisons of the pretreatment and post-treatment values.

Measurements	Pretreatment (Mean ± SD)	Post-treatment (Mean ± SD	Change (Mean ± SD)	*p*
Linear measurements (millimetres)				
Upper incisor tip	79.8 ± 4.4	73.9 ± 5.0	-5.9 ± 2.3	**< 0.001**
Lower incisor tip	75.7 ± 4.8	71.8 ± 5.2	-3.9 ± 4.2	**< 0.050**
Upper lip thickness	12.8 ± 1.5	13.3 ± 1.0	0.5 ± 0.9	0.160
Lower lip thickness	14.5 ± 1.3	14.7 ± 1.4	0.2 ± 0.5	0.220
Lip strain	1.6 ± 0.7	0.9 ± 0.7	-0.7 ± 0.8	**< 0.050**
Point A'	84.6 ± 3.8	83.4 ± 4.1	-1.2 ± 1.0	**< 0.050**
Upper lip anterior	86.6 ± 4.1	84.8 ± 5.8	-1.8 ± 1.8	**< 0.050**
Lower lip anterior	83.2 ± 3.8	82.3 ± 5.9	-0.9 ± 2.1	0.200
Point B'	75.3 ± 5.1	74.2 ± 6.3	-1.1 ± 1.7	0.080
Upper lip depth	5.6 ± 1.1	4.1 ± 1.7	-1.5 ± 0.7	**< 0.001**
Lower lip depth	12.1 ± 1.4	10.9 ± 1.6	-1.1 ± 1.1	**< 0.050**
Interlabial gap	7.3 ± 2.3	3.4 ± 2.0	-3.7 ± 2.9	**< 0.001**
Angular measurements (degrees)				
Nasolabial angle	83.9 ± 13.4	99.1 ± 13.4	15.2 ± 6.5	**< 0.001**
Labiomental angle	86.0 ± 18.3	98.4 ± 12.5	12.2 ± 15.2	**< 0.050**
Interincisal angle	104.9 ± 13.7	126.7 ± 6.0	21.8 ± 12.8	**< 0.001**

Paired *t*-test, significant values are in bold

Table II. Associations between the hard and soft tissue changes.

	Maxillary incisor change		Mandibular incisor change	
	r	*p*	r	*p*
Nasolabial angle	-.630	**<0.05**	-	-
Labiomental angle	-	-	-.420	0.22
Upper lip anterior	.790	**<0.01**	-.100	0.81
Lower lip anterior	.114	0.76	.340	-0.33
Upper lip depth	.520	0.13	-	-
Lower lip depth	-	-	.050	0.15

Significant values are in bold

perpendicular to the vertical reference line and upper and lower lip thicknesses were measured as shown in Figure 3.[11] The interlabial gap was measured parallel to the vertical reference line. The linear measurements were adjusted for magnification at the time they were recorded.

Statistical analysis

Changes occurring during treatment were calculated and analysed using Minitab Statistical software, Version 14. Pre- and post-treatment comparisons were carried out using the paired *t*-test. Pearson's correlation coefficients were calculated to determine associations between changes in the upper and lower incisors and changes in the nasolabial angle, labiomental angle, upper lip anterior, lower lip anterior, upper lip depth and lower lip depth. A stepwise regression analysis was also performed to obtain the ratios between the dental and soft tissue structures. The 0.05 level of probability was used in all tests.

Results

There were eight statistically significant linear changes and three statistically significant angular changes during treatment. Only changes in upper and lower lip thickness, B' point and lower lip anterior were not significant (Table I). The upper and lower incisor tips were retracted, on average, 5.9 and 3.9 mm, respectively. These changes were accompanied by marked changes in the nasolabial, labiomental and interincisor angles and a reduction in the interlabial gap.

A significant positive correlation was found between upper incisor retraction and upper lip retraction (r = .79), and a significant negative correlation was

found between upper incisor retraction and change in the nasolabial angle (r = -.63) (Table II). There were no significant associations between changes in the lower incisors and the lip measurements. A weak negative correlation was observed between lower incisor retraction and the labiomental angle. Changes between upper lip depth and the upper incisors and lower lip depth and the lower incisors also showed weak correlations.

Stepwise multiple regression analyses showed that for every 1 mm of upper incisor retraction, the most anterior point on the upper lip retracted 0.04 mm and the nasolabial angle increased by 2.58 degrees; for every 1 mm of lower incisor retraction, the most anterior point of the lower lip retracted 0.05 mm and the labiomental angle increased by 3.08 degrees.

Discussion

Many factors determine the need for extractions including crowding, the curve of Spee, incisor proclination, buccal occlusion, dentofacial aesthetics, surgical decompensation, pathology and the facial profile. The latter is especially important in deciding whether or not to extract premolars in bimaxillary protrusion cases. We selected young adult South Indian females with bimaxillary dentoalveolar protrusion who had four first premolar extractions as a part of their orthodontic treatment. In agreement with others, we found that premolar extractions and retraction of upper and lower incisors in these non-growing subjects were accompanied by favourable changes in the soft tissue profiles.

In retrospective cephalometric studies, soft tissue measurements may be confounded by soft tissue activity during imaging. We could not estimate the effect of this on our findings, but we attempted to have the lips relaxed during the actual exposure.[24,26,33] Some of the changes we found were very small and highly variable, and cannot be applied to other patients. Furthermore, just because a correlation coefficient is significant it does not mean that one variable (e.g. upper incisor retraction) causes a second to happen (e.g. nasolabial angle to increase or the upper lip to drop back) and both variables may be under the influence of an unknown third variable. The square of the correlation coefficient gives the proportion of the variance in the nasolabial angle explained by upper incisor retraction: it was only 40 per cent.

The effect of growth on the soft tissues has been extensively reported in the orthodontic literature. In growing individuals the soft tissue changes include an elongation of nose, flattening of the lips and increasing chin prominence.[10,17,18] Behrents,[17] reported that facial growth continued well into adult life and vertical changes were more prominent than anteroposterior changes in adults. He also observed that there was an apparent deceleration of growth in females in the late teens followed by a resumption of growth in the second decade, which coincided with pregnancy. Similar findings were reported by Bishara et al.,[18] who also noted that the greatest changes in soft tissue profiles in females occurred between 10 and 15 years of age: the upper and lower lips retruded in relation to the E-line. We avoided confounding changes due to growth by selecting a sample of adult women (Mean age at the start of treatment: 18.2 ± 1.2 years). The mean treatment time for our study was only 19.6 ± 2.6 months, thus, any growth-related changes in the soft tissues during treatment would have been small.

Gender differences were avoided by selecting only adult females from a local population, broadly defined as a 'South Indian population'. This population has a markedly different craniofacial form to that found in Caucasians, as noted by Kalha et al.[16] South Indian subjects have more deep-set midfacial structures and more protrusive dentitions. Previous studies evaluating lip profile changes following extractions have used Caucasian,[6,9–12] African American[19] and Asian[20–22] samples. Our study is unique as no data exists for the South Indian population and it may provide useful information for clinicians treating South Indians with similar malocclusions.

The upper and lower incisors were retracted almost 6 mm and 4 mm, respectively, and the interincisor angle was reduced by almost 22 degrees. These dental changes may be critical in bringing about the soft tissue changes in our subjects. When treating bimaxillary dentoalveolar protrusions by retracting the upper and lower incisors, the nasolabial and labiomental angles increase as the lips drop back and the profile becomes less prognathic.[20] An important finding in our study was the reduction in the prominence of the upper and lower lips. Our finding of a significant association between incisor retraction and response of the upper lip to retraction agrees with other studies,[10,23,24] but upper incisor change only

accounted for 62 per cent of the variance in the position of the upper lip, indicating that other factors have a role in the change. Studies in Caucasians have reported ratios for upper lip to incisor retraction, ranging from 1:1.6 to 1:3.8;[19,25] our ratio was 1:2.3. The difference in ratios may be attributed to the amount of incisor retraction and the characteristics of the soft tissues and facial skeletons of our distinct ethnic group.

During treatment the lower lip dropped back less than 1 mm and there were no significant associations between the change in the lower incisors and the four variables we used. In contrast, Kocadereli[7] and Xu et al.[21] reported that premolar extractions reduced the prominence of the lower lip and B' point. In bimaxillary protrusion, the lower lip usually contacts the proclined upper and lower incisors and both incisors influence the position of the lower lip.[19] In agreement with others we found small, but statistically significant, reductions in the depths of the upper and lower lips during treatment,[26,27] but no significant associations between the changes in the incisors and lip depths. Moseling and Woods[27] also reported reductions in the curvatures of the upper and lower lips following extractions: the more protrusive and proclined the upper incisors were before treatment the greater the likelihood of reductions in lip curve depths during treatment.

The form of the nasolabial soft tissue is important when contemplating orthodontic treatment. Movement of the upper incisors in any one of the three planes of space influences this area.[9,10,14,28,29] Drobocky and Smith[30] proposed that an ideal range for the nasolabial angle was 90 to 120 degrees. We found that during treatment the nasolabial angle increased from 84 to 99 degrees: the latter falls within the range suggested by Drobocky and Smith.[30] The change in the nasolabial angle was significantly and negatively associated with change in the upper incisors. The coefficient, although high, only accounts for approximately 40 per cent of the variance. For every 1 mm of incisor retraction the nasolabial angle increased by 2.58 degrees, which is higher than the figures reported by Lo and Hunter (1:1.63 degrees)[8] and Talass et al. (1:0.8 degrees).[24] Bearing in mind the variance and the ethnicity of our subjects, these ratios may serve as a aid for treatment planning in cases with bimaxillary dentoalveolar protrusion.

The labiomental angle also reduced significantly during treatment and contributed to an improvement in the facial profile. De Smit and Dermaut[31] also suggested that the labiomental angle plays an important role in aesthetic evaluation. However, Bravo[32] noticed that changes in the labiomental angles were not as significant as other soft tissue parameters. In our study, for every 1 mm of lower incisor retraction the labiomental angle increased by 3 degrees. The lower lip, which is usually everted before treatment, 'straightens' during treatment thus reducing the lower lip depth and increasing the labiomental angle. Pretreatment, the subjects had pronounced interlabial gaps and, in most subjects, the incisors prevented the lips from meeting. As the incisors were retracted, the everted upper and lower lips moved backwards and towards each other, thus reducing the interlabial gap by almost 4 mm. But only the change in the anterior point on the upper lip was significant. A similar correlation between incisor movement and the interlabial gap was reported by Jacobs.[29] A small, statistically significant backwards movement of A' point occurred during treatment and a similar change occurred in B' point, but it was not significant. Xu et al.,[21] on the other hand, reported a significant reduction in B' point in their study.

We conclude that extraction of the four first premolars followed by the retraction of incisors reduces the prominent incisors and soft tissues found in adult South Indian females with bimaxillary dentoalveolar protrusion.

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