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Comparative assessment of soft-tissue changes in Class II Division 1 patients following extraction and non-extraction treatment

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ABSTRACT

Background: The extraction of teeth for orthodontic purpose has always been a controversial subject in the speciality. The aesthetics impact of the soft-tissue profile might play a key role in deciding on premolar extraction or non-extraction (NE) treatment, particularly in borderline patients. The purpose of this cephalometric study was to examine the soft-tissue treatment effects of Class II Division 1 malocclusion undergoing extraction of all first premolars in comparison with patients undergoing treatment with a NE approach.

Materials and Methods: Hundred post-pubertal female patients of Class II Division 1 malocclusion were selected. Group 1, treated with four first premolar extractions, consisted of 50 female patients with a mean age of 14 years 1 month. Group 2, treated without extractions, consisted of 50 patients with a mean age of 13 years 5 months. Pre-treatment and post-treatment lateral cephalograms of the patients were obtained. The pre-treatment and post-treatment stage comparison and the intergroup comparison of the treatment changes were conducted between extraction and NE groups of Class II malocclusion samples with *t* tests. The levels of significance tested were $P < 0.05$ and $P < 0.01$.

Results: The main soft-tissue differences between the groups at the end of treatment were a more retruded lower lip and a more pronounced lower labial sulcus in those patients subjected to extraction.

Conclusion: In Class II Division 1 patients, the extraction or NE decision, if based on sound diagnostic criteria, seems to have no systematic detrimental effects on the facial profile.

Key Words: Borderline extraction- NE subjects and standard edgewise mechanics, dentoskeletal changes, extraction- NE subjects and Class II Division 1, soft-tissue profile

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INTRODUCTION

Class II malocclusions are frequently observed in orthodontic practice and are characterized by an incorrect relationship between the maxillary and mandibular arches because of skeletal or dental problems or a combination of both.[1] Premolar extractions might be necessary for patients who have some crowding and protrusion.

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Extraction patterns have changed over time. Due to possible side-effects of premolar extraction, non-extraction (NE) treatment became increasingly common in the 1970s. Until now numerous studies have compared the fluctuating patterns of positive and negative perceptions of the esthetic effects of extraction and NE orthodontic treatments.[2-5] The role of facial esthetics on the extraction decision has been increased.[6,7] Each patient's treatment (Extraction or NE) should be based on specific diagnostic criteria,[8] such as evaluation of the arch length discrepancy, mandibular incisor protrusion, curve of spee, and lip protrusion, the indications, and possibilities of securing space in the upper jaw by distalizing the upper molars and evaluation of the general consequences on the soft-tissues of the facial profile.

The purpose of this study was is to assess whether extraction or NE treatment has an impact on facial attractiveness, by comparing orthodontic treatment outcomes in Indian female patients with border line Class II problems.

MATERIALS AND METHODS

A total of 100 borderline (Angle between Lines, Nasion to Point A and Nasion to Point B (ANB) < 5°, over jet < 5 mm.,) Class II North Indian patients were selected from the files of orthodontics department. Only female patients were selected, to minimize the effects attributable to residual growth and exclude possible differences in response between sexes. Patients were excluded based on their initial diagnostic record. Patients with craniofacial congenital anomalies, significant facial asymmetries, Class II Division 2 malocclusion, Class II patients with an ANB angle more than 5° on the initial lateral cephalogram analysis and single arch extraction cases were excluded. All patients were to be treated with edgewise appliances. A total of 100 investigated patients were grouped as Table 1.

Method

The cephalograms obtained from the orthodontic department had been taken by properly positioning the patients on a Universal Counterbalancing type of cephalostat with the Frankfort horizontal plane parallel to the floor and the teeth in centric occlusion. All cephalograms had been taken with patients in a standing position with relaxed lips.[9]

After placing registration points on the cephalogram, the pre- and post-treatment radiographs were traced on acetate tracing sheets 0.5 microns in thickness using a sharp 4H pencil on a view box using trans illuminated light in a dark room. Where there was a lack of superimposition of the right and left structural outline, the average between the two was drawn by inspection and the cephalometric points were located in reference to the arbitrary line so obtained. The linear and angular measurements were made to the nearest 0.5 mm and 0.5° respectively with the help of scale and protractor.

Table 1: Group division of the selected sample

Groups	No. of patients	Mean age	Average duration of treatment
Group 1 (E4): Four first premolars were extracted	50	14 years 1 month	24 months to 30 months
Group 2 (NE): No teeth were extracted	50	13 years 5 months	18 months to 24 months

NE: Non-extraction

METHODS OF ANALYSIS

Following cephalometric points (Soft-Tissue Landmarks[10]) were used in the present study [Figure 1].

1. Soft-tissue nasion
2. Subnasale
3. Superior sulcus depth
4. Labrale superior
5. Stomion superius
6. Stomion inferius
7. Labrale inferius
8. Inferior labial sulcus
9. Soft-tissue Pogonion
10. Soft-tissue menton.

SOFT-TISSUE MEASUREMENTS

Angular

Following angular measurements were taken for the study [Figure 2].

1. Nasolabial angle: Angle formed between tangent to columella and tangent to upper lip
2. Mentolabial angle: Angle formed between tangent to soft-tissue chin and tangent to lower lip at inferior labial sulcus (ILS)
3. Z-angle: Angle formed between Frankfort horizontal plane (FH) plane and most protrusive lip to pog line
4. N`-Sn-Pog': Facial convexity.

Linear

Following linear measurements were taken for the study [Figure 3].

1. Sulcus superius-E line
2. Sulcus inferius-E line
3. Max. 1 to labrale superius
4. Md. 1 to labrale inferius
5. Sn-Stms: Upper lip length
6. Stmi-ILS: Lower lip length
7. Stms-Stmi: Interlabial gap

Reliability of landmark location and measurements

All cephalograms were obtained on the same cephalometric unit. All landmarks were identified by one investigator and checked for accuracy of location by a second investigator. The landmarks were digitized twice on separate occasions by two investigators. Allowable intra-investigator and inter-investigator discrepancies were pre-determined at 0.5 mm and 0.5°. The readings, which showed an increase in the post-treatment value as compared to pre-treatment values, were recorded as positive while those, which decreased after treatment were recorded as negative.

STATISTICAL METHODS USED FOR ANALYSIS OF DATA

Means and standard deviations of the 11 variables previously described were calculated for both groups before and after treatment. The means and standard deviations for the differences that each treatment group experienced from pre-treatment to post-treatment were also calculated. Independent-sample *t* tests were performed to test the significance of the differences between the change values of the two different treatment groups. Paired *t* tests were performed to test the null hypothesis that no differences exist within the same treatment group between the onset and the end of treatment in the cephalometric measurements. The levels of significance tested were $P < 0.05$ and $P < 0.01$.

Reliability of measurement was tested by doing double determinations of 10 cephalograms randomly selected at 15 days interval from the collect sample, by the same operator and comparison was drawn between 1st and 2nd determinations.

OBSERVATIONS

The present study includes pre-treatment and post-treatment lateral head cephalogram of hundred orthdontically treated patients in the age range of 13 years to 16 years. All the subjects had undergone treatment using the standard edgewise technique.

All cephalograms were traced and analyzed for soft-tissue variables (4 angular and 7 linear). The data was sequentially evaluated in following manner:

Aims

To compare the pre-treatment characteristics of two groups [Table 2].

To find out the changes in soft-tissue variables with treatment in each group [Tables 3 and 4].

To compare the post-treatment changes taking place in soft-tissue variables from one group to another [Table 5].

RESULTS

On comparison of pre-treatment soft-tissue profiles of extraction and NE groups statistically significant difference was found for both the angular (nasolabial angle, mentolabial angle) as well as linear variables (Sulcus Inf.- E lines, Stml-ILS, Stms-Stmi) suggesting more protruded upper and lower lips in the extraction group [Table 2].

Tables 3 and 4, lists descriptive statistics for changes in facial profile after orthodontic treatment with and

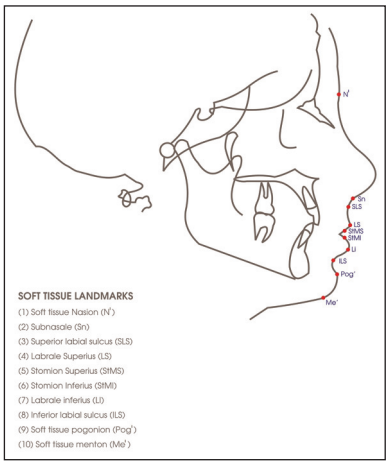


Figure 1: Soft-tissue landmarks used in the study

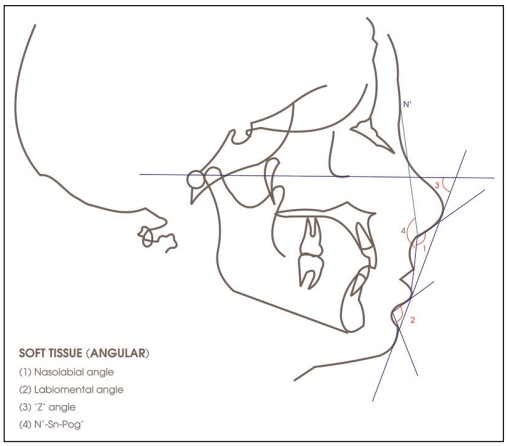


Figure 2: Angular variables analyzed

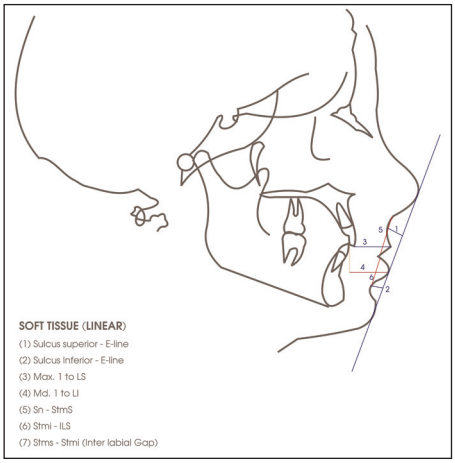


Figure 3: Linear variables analyzed

Table 2: Extraction versus non-extraction: Descriptive and inferential statistics of mean value difference: Soft-tissue analysis pre-treatment values

Name of variables	Pre-treatment extraction (Group 1)	Pre-treatment non-extraction (Group 2)	*t* value	*P* value
Angular variables (in degrees)				
Nasolabial angle	101.15±8.11	107.79±7.39	2.74	<0.05*
Mentolabial angle	99.46±15.32	108.14±13.36	3.98	<0.01**
Z angle	59.77±5.76	57.50±2.47	2.23	<0.05*
N' — Sn — Pog'	157.15±3.65	153.51±8.18	1.34	NS
Linear variables (in mm)				
Sulcus superior — E line	7.30±0.75	7.64±1.55	0.48	NS
Sulcus Inferior — E line	5.38±1.75	4.00±2.19	2.65	<0.05*
Max. 1 to Labrale superior	9.69±2.90	11.21±4.07	2.15	<0.05*
Md. 1 to Labrale inferius	12.62±2.47	11.36±1.55	2.68	<0.05*
Subnasale-Stomian superior	19.31±2.46	19.03±2.50	1.33	NS
Stomian inferius-inferior labial sulcus	13.85±2.08	14.93±1.86	2.03	<0.05*
Stomian superior-Stomion inferius	6.31±3.88	3.71±1.33	3.58	<0.01**

***P<0.001: Highly significant, **P<0.01: Significant, *P<0.05: Just significant, NS>0.05: Non-significant

Table 3: Extraction sample (Group-1): Descriptive and inferential statistics of the soft-tissue analysis results (*N*=50)

Name of variables	Pre-treatment mean±SD	Post-treatment mean±SD	Change in mean±SD	*t* value	*P* value
Angular variables (in degree)					
Nasolabial angle	101.15±8.11	108.00±7.37	6.84±8.56	2.88	<0.01**
Mentolabial angle	99.46±15.32	109.38±7.98	4.92±12.94	1.37	NS
Z angle	59.77±5.76	63.76±7.51	4.00±3.53	4.07	<0.01**
N' — Sn — Pog'	157.15±3.65	158.85±3.91	1.69±3.04	2.01	NS
Linear variables (in mm)					
Sulcus superior — E line	7.30±0.75	8.30±0.75	1.00±1.00	3.61	<0.01**
Sulcus Inferior — E line	5.38±1.75	6.31±1.65	0.92±1.55	2.14	NS
Max. 1 to Labrale superior	9.69±2.90	12.00±1.78	2.30±2.14	4.58	<0.001***
Md. 1 to Labrale inferius	12.62±2.47	14.69±2.32	2.08±1.93	3.87	<0.01**
Subnasale-Stomian superior	19.31±2.46	21.23±2.39	1.92±1.50	2.63	<0.05*
Stomian inferius-inferior labial sulcus	13.85±2.08	15.31±1.84	1.46±1.39	3.79	<0.01**
Stomian superior-Stomion inferius	6.31±3.88	3.31±4.01	3.00±2.55	4.24	<0.001***

***P<0.001: Highly significant, **P<0.01: Significant, *P<0.05: Just significant, NS>0.05: Non-significant, SD: Standard deviation

Table 4: Non-extraction sample (Group 2): Descriptive and inferential statistics of soft-tissue analysis (*N*=50)

Name of variables	Pre-treatment mean±SD	Post-treatment mean±SD	Change in mean±SD	*t* value	*P* value
Angular variables (in degree)					
Noso labial angle	107.79±7.39	108.93±7.23	1.14±4.54	0.94	NS
Mentolabial angle	108.14±13.36	109.60±12.70	1.43±3.92	1.36	NS
Z angle	57.50±2.47	58.43±4.79	0.92±3.54	0.97	NS
N' — Sn — Pog'	153.51±8.18	151.48±7.45	−1.43±3.06	2.20	<0.05*
Linear variables (in mm)					
Sulcus superior — E line	6.79±1.12	7.64±1.55	0.15±1.29	0.48	NS
Sulcus Inferior — E line	5.86±1.66	4.00±2.19	−1.86±2.25	2.24	<0.05*
Max. 1 to Labrale superior	10.64±2.73	11.21±4.07	0.57±4.43	1.33	NS
Md. 1 to Labrale inferius	13.57±1.28	11.36±1.55	−2.21±0.98	2.02	<0.01**
Subnasale-Stomian superior	18.36±2.27	19.03±2.50	0.67±1.86	2.18	<0.05*
Stomian inferius-inferior labial sulcus	14.00±1.52	14.93±1.86	0.93±1.73	2.17	<0.05*
Stomian superior-Stomion inferius	4.86±4.79	3.71±1.33	−1.14±4.29	2.74	<0.05*

***P<0.001: Highly significant, **P<0.01: Significant, *P<0.05: Just significant, NS>0.05: Non-significant, SD: Standard deviation

Table 5: Extraction versus non-extraction: Descriptive and inferential statistics of mean value changes: Soft-tissue analysis post-treatment result

Name of variables	Extraction (post-treatment)	Non-extraction (post-treatment)	*t* value	*P* value
Angular variables (in degrees)				
Nasolabial angle	108.00±7.37	108.93±7.23	2.18	<0.05*
Mentolabial angle	109.38±7.98	109.60±12.70	0.96	NS
Z angle	63.76±7.51	58.43±4.79	2.26	<0.05*
N' — Sn — Pog'	158.85±3.91	151.48±7.45	1.48	NS
Linear variables (in mm)				
Sulcus superior — E line	8.30±0.75	7.64±1.55	0.31	NS
Sulcus Inferior — E line	6.31±1.65	4.00±2.19	1.04	NS
Max. 1 to Labrale superior	12.00±1.78	11.21±4.07	1.28	NS
Md. 1 to Labrale inferius	14.69±2.32	11.36±1.55	2.21	<0.05*
Subnasale-Stomian superior	21.23±2.39	19.03±2.50	3.58	<0.01**
Stomian inferius-inferior labial sulcus	15.31±1.84	14.93±1.86	0.75	NS
Stomian superior-Stomion inferius	3.31±4.01	3.71±1.33	1.76	<0.05*

***P<0.001: Highly significant, **P<0.01: Significant, *P<0.05: Just significant, NS>0.05 Non significant

without extractions. Results showed improvement of soft tissue profile for both the groups. Upper and lower lip prominence (maxillary central incisor to labrale superior, mandibular central incisor to labrale inferius, Sn-Stms, Stml-ILS, Stms-Stmi) decreased relative to the nose and chin in the extraction groups. Changes in upper and lower lip protrusion relative to the E line and Sn-Pog indicated an average decrease in lip protrusion of 1 mm.

In the NE group, the differences in the results were limited and consistent, upper and lower lip (I to LS, I to LI, Sn-Stms, Stml-ILS) was found to become slightly protrusive when compared to their pre-treatment values.

On post-treatment intergroup comparison on average, NE patients had less facial change as a result of orthodontic treatment than a similar group of extraction patients. The upper lip prominence (Sn-Stms) was found less in the extraction groups when compared to the corresponding NE groups and the lower lips (Stml-ILS) were more protrusive among the NE groups. Lower incisor protrusion (I to LI) showed a slight decrease among the extraction groups and an increase among subjects treated without extractions [Table 5].

DISCUSSION

The main purpose of the study was to compare soft-tissues profile changes between a sample of patients where extractions were considered necessary and another similar sample, where reasonable doubt existed as to whether or not to perform extractions. In this latter group, a more conservative treatment approach was adopted.

The comparison of pre-treatment values for both the groups showed that the extraction group had slightly more protrusive soft-tissue profile as compared to NE group (nasolabial angle and Z-angle $P < 0.05$, mentolabial angle $P < 0.05$). Maxillary and mandibular incisors were also found more proclined in extraction group and the difference was statistically significant. That became the decisive factor for two different treatment modalities (extraction treatment or NE treatment) [Table 2].

The change in the soft-tissue profile caused by tooth movement has distinct characteristics, which cannot be calculated or easily described in a formula. Facial soft-tissue configuration may be as variable as malocclusion itself. Changes observed in the morphological characteristics of the soft-tissues of patients treated with extractions and NE following active treatment is shown in Tables 3 and 4.

In extraction group, significant mean increase [Bar diagram 1] was observed for nasolabial angle and Z-angle; thus, making the profile straighter and pleasing. Increase in these angles can be related to upper incisor retraction. According to Drobocky and Smith,[2] normal range for nasolabial angle was between 90° to 120° with a desirable value of approximately 100-105°. This was supported by Talass *et al.*,[11] Finnöy *et al.*[12] James[13] used Merrifield's Z-angle to quantity and compare the pre-treatment and post-treatment profiles of the extraction and NE groups used in their study and found an increase of about 6° in the value of Z-angle in extraction group. Finnöy *et al.*[12] evaluated profile changes in 30 Class II, Division 1 cases treated with

an edgewise appliance after extraction of four first premolars. They found mean changes of 6.5° for the nasolabial angle, −3.3 mm for LS to E line, and −2.5 mm for Li to E line. These changes are almost close to values reported in Table 3.

Findings were also in accordance with Bravo,[14] who revealed that sulcus superior and sulcus inferior moved back an average of 1.6 mm and 2.3 mm to E-line respectively. In his study, I-LS (upper lip thickness) also increased 2.30 mm following treatment. Anderson *et al.*[15] reported a similar finding. increase in upper lip height was about 1.92 mm while lower lip height increase was 1.46 mm that is supported by study carried out by Abdel Kader[16] on Class II Division 1 patients. He observed vertical lip height increase with treatment, but the increase is statistically insignificant at the one present level.

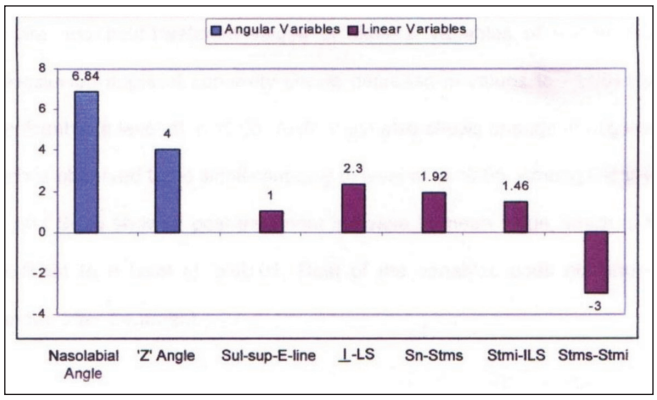
Decrease in inter-labial gap (Stms-Stmi) was found to be influenced uniformly by retraction of maxillary incisors. About 3 mm decrease in inter-labial gap was observed. Jacobs[17] gave a similar finding and stated that decrease in inter-labial gap can be predicted by retraction and intrusion of maxillary incisors.

In NE group [Bar diagram 2] decrease in lower lip thickness was about 2 mm and this was due to protrusion of lower incisors. Changes in vertical height of upper and lower lip were found to be statistically significant in this group. However, this is a matter of controversy and described previously.

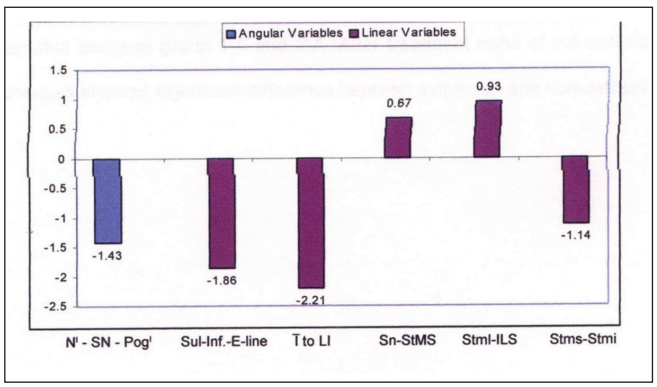
Inter-labial gap reduction was less significant than in the extraction group. This finding is based on the facts that upper lip retraction occurred and lip strain was eliminated. This finding is in accordance to that of Jacobs[17] and Talass *et al.*[11] who also reported decrease in inter-labial gap following retraction of maxillary incisors.

Prominence of lower lip increased due to decrease in linear distance between I-LI by about 1.86 mm, which is due to mild proclination of lower incisors in attempt to relieve the crowding in NE group. Saelens and Smit,[18] and Finnöy *et al.*,[12] in their study found nasolabial angle increased in extraction group, but the less pronounced mean increase in the NE group was not significantly same as in present study.

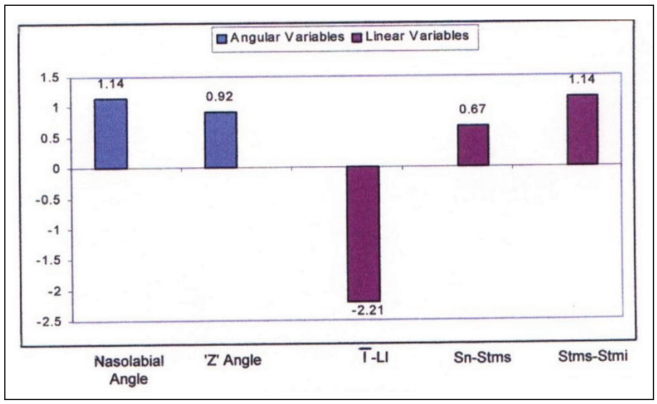
When comparison was made between extraction and NE groups [Table 5, Bar diagram 3] Improvement in nose, lip, chin relationship depicted by increase in



Bar diagram 1: Significant soft-tissue changes in Group 1 (Class II malocclusion extraction group)



Bar diagram 2: Significant soft-tissue changes in Group 2 (Class II malocclusion non-extraction group)



Bar diagram 3: Comparison of significant soft-tissue changes in Group 1 and Group 2 (extraction and non-extraction Class II malocclusion)

Z-angle is found to be more in extraction group (about 40) than NE group (0.920). Findings are supported by James,[13] Saelens and Smit,[18] and Finnöy *et al.* (1987),[12] who reported that NE group completed treatment with a slightly more protrusive lip profile position than did the extraction group. Linear distance

between lower central incisors to LI was found to be increased in extraction group by 2.08 mm, while it decreased in NE group (2.21 mm). Zierhut *et al*.[19] noted greater lower lip retraction relative to the esthetic plane in the extraction sample of study. Caplan and Shivpuja[20] supported the present finding and found decrease in upper and lower lip thickness during NE.

Increase in upper lip length (Sn-Stms) was found to be more in extraction group. Rains and Nanda[21] stated that upper lip response was related to both upper and lower incisor movement, mandibular rotation and lower lip. Burstone,[22] Hershey,[23] and Xu *et al*.[24] proposed that the perioral soft-tissue may be self-supporting and factors other than dental movement may cause wide variability of individual response.

Decrease in inter labial gap was also more pronounced in extraction group than NE group. The variable is found to be influenced uniformly by a retraction of maxillary incisors. Jacobs[17] presented a similar finding and stated decrease in inter-labial gap can be predicted by retraction and intrusion of maxillary incisors, which is obviously more in extraction group. Harmony in lip posture is found by the balance of soft-tissue thickness over the skeletal frame-work. Yogosawa[25] stated when observing closure of the inter-labial gap, it is interesting to note that lower lip requires four times the upper lip movement.

These comparisons suggest that the extraction or NE decision, if based on sound diagnostics, seem to have no systematic detrimental effects on the facial profile.

CONCLUSIONS

1. Lip protrusion is an important pre-treatment profile characteristic that influences the extraction or NE decision.
2. After treatment, it was observed that (a) the soft-tissue convexities was straighter in extraction group more than in the NE group; (b) the upper and lower lip were more retrusive in the extraction groups and more protrusive in the NE groups.

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