

# Comparison of esthetic outcome after extraction or non-extraction orthodontic treatment in class II division 1 malocclusion patients

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## Abstract

**Introduction:** The extraction of premolars as a practical form of orthodontic therapy has been accepted for many years, but there remains a controversy regarding the effect of premolar extraction to improve esthetics as well as dentoskeletal relationship. The esthetic impact of the soft-tissue profile might play a major role in deciding on premolar extraction or non-extraction treatment, particularly in borderline patients. This cephalometric study was undertaken to compare the post-treatment soft-tissue profiles of successfully managed Class II, Division 1 malocclusions treated with either all first premolar extractions or treatment with a non-extraction therapy. **Materials and Methods:** The sample consisted of 100 post-pubertal female patients of Class II Division I malocclusion. 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 cephalometric radiographs were evaluated. The pre-treatment to post-treatment stage comparison and the intergroup comparison of the treatment changes were conducted between extraction and non-extraction groups of Class II malocclusion samples with *t*-tests. **Results:** The soft-tissue facial profiles of the extraction and non-extraction samples were the same following active treatment except for a more retruded lower lip and a more pronounced lower labial sulcus in those patients subjected to extraction. **Conclusions:** The extraction or non-extraction decision, if based on sound diagnostic criteria, seems to have no systematic detrimental effects on the facial profile.

**Keywords:** Dentoskeletal changes, extraction-non-extraction patients, standard edgewise mechanics, soft-tissue profile

## 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.<sup>[1]</sup> Premolar extractions might be necessary for patients who have some crowding and protrusion.

Extraction patterns have changed over time. Due to the possible side effects of premolar extraction, non-extraction

treatment became increasingly common in the 1970s. Until time numerous studies have compared the fluctuating patterns of positive and negative perceptions of the esthetic effects of extraction and non-extraction orthodontic treatments.<sup>[2-5]</sup> The role of facial esthetics on the extraction decision has increased in importance.<sup>[6,7]</sup> Each patient's treatment (extraction or non-extraction) Should be based on specific diagnostic criteria<sup>[8]</sup> 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.

Thus, the study was designed to assess whether the extraction or non-extraction treatment has an impact on facial attractiveness, by comparing orthodontic treatment outcomes in Indian female patients with border line Class II problems.

## Objectives

1. To evaluate the treatment changes in soft-tissue variables in extraction and non-extraction groups
2. To compare the changes taking place in soft-tissue variables from one group to another.

## Materials and Methods

A total of 100 borderline Class II North Indian female patients were selected from the files of Orthodontics Department. Only female patients were selected, to minimize the

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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 (Difference between SNA and SNB angle) angle more than 5° on the initial lateral cephalogram analysis and single arch extraction cases were excluded. All patients were to be treated with fixed edgewise mechanics. Selected samples were grouped as Table 1.

The cephalograms obtained from the department had been taken by properly positioning the patients on a universal counterbalancing type of cephalostat with the Frankfort horizontal (FH) 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.<sup>[9]</sup>

Specific criteria for inclusion in this study included the availability of high-quality pre-treatment and post-treatment cephalometric radiographs that clearly showed the soft-tissue profile.

After placing registration points on the cephalogram, the pre-treatment and post-treatment radiographs were traced on acetate tracing sheets 0.5 µm in thickness using a sharp 4H pencil on a view box using transilluminated 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.

### Method of analysis

Soft-tissue landmarks used in study are depicted in Figure 1.<sup>[10]</sup>

### Soft-tissue measurements

#### Angular [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 ILS
3. 'Z' angle: Angle formed between FH plane and most protrusive lip to pog line
4. N'-Sn-Pog': Facial convexity.

#### Linear [Figure 3]

1. Sulcus superius - E line
2. Sulcus inferius - E line

3. Max. 1 to labrale superius
4. Md. Mandibular 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 first and second determinations.

### Results

All cephalograms were traced and analyzed for soft-tissue variables (4 angular and 7 linear). Pre-treatment and post-treatment mean soft-tissue profile measurements for the extraction and non-extraction groups are presented in Tables 2 and 3. A comparison of the treatment changes for the extraction and non-extraction groups was done. The results of the soft-tissue profile evaluation from the cephalometric tracings gave very similar findings for both groups [Table 4].

**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  | 24-30 months                  |
| Group 2 (NE): No teeth were extracted             | 50              | 13 years 5 months | 18-24 months                  |

E: Extraction; NE: Non-extraction

Significant differences between groups were found for the changes in lower lip and lower incisor only. Significantly, greater retraction of the lower lip relative to the esthetic plane was observed in the extraction group.

## Discussion

Attaining (or maintaining) general harmony and balance among the various facial features by predicting the individual response to treatment becomes part of an orthodontist's responsibility.

The main purpose of the study was to compare soft-tissues profile changes occurring in Class II Division 1 patients treated orthodontically with premolar extraction with those occurring in Class II Division 1 patients treated without extraction. Chosen sample was divided in the groups on basis 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 decision to extract the premolar was based on the fact that how to resolve the tooth size-arch length discrepancy and assessing the final pre-determined position of the mandibular incisors without appreciable expansion of the lower arch. The maxillary incisors were supposed to be positioned in a proper relationship with the mandibular incisors.<sup>[11]</sup>

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 non-extraction following active treatment is shown in Tables 2 and 3.

Significant mean increase [Figure 4] 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<sup>[2]</sup> normal range for nasolabial angle was between 90° and 120° with a desirable value of approximately 100-105°. This was supported by Talass *et al.*,<sup>[12]</sup> and Finnoy

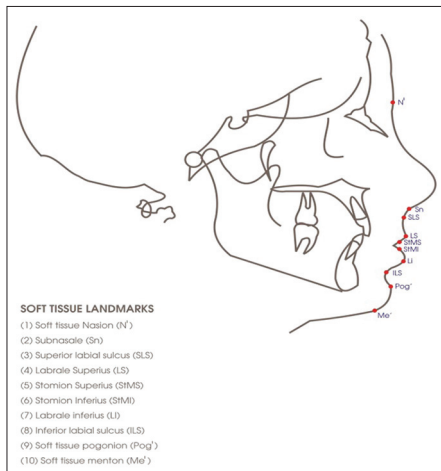


Figure 1: Soft-tissue landmarks used in the study

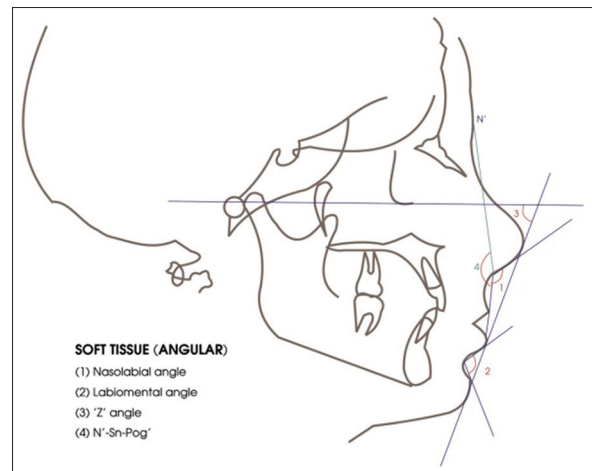


Figure 2: Angular variables analyzed

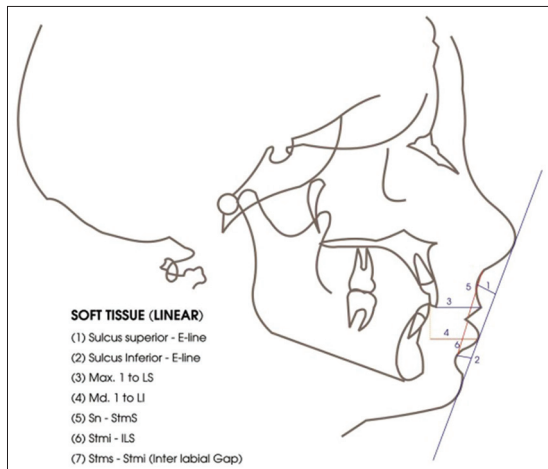


Figure 3: Linear variables analyzed

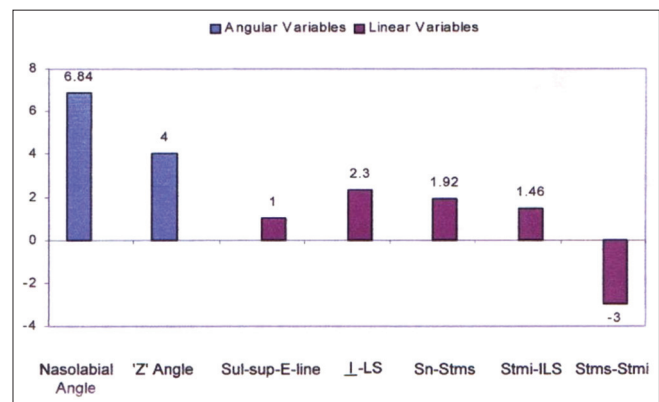


Figure 4: Significant post-treatment changes for soft-tissue variables in extraction group plotted on bar diagram

**Table 2: 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)      |                       |                        |                   |         |           |
| Sul-sup-E line                | 7.30±0.75             | 8.30±0.75              | 1.00±1.00         | 3.61    | <0.01**   |
| Sul-inf.-E line               | 5.38±1.75             | 6.31±1.65              | 0.92±1.55         | 2.14    | NS        |
| 1 to LS                       | 9.69±2.90             | 12.00±1.78             | 2.30±2.14         | 4.58    | <0.001*** |
| 1 to LI                       | 12.62±2.47            | 14.69±2.32             | 2.08±1.93         | 3.87    | <0.01**   |
| Sn-Stms                       | 19.31±2.46            | 21.23±2.39             | 1.92±1.50         | 2.63    | <0.05*    |
| Stmi-Ils                      | 13.85±2.08            | 15.31±1.84             | 1.46±1.39         | 3.79    | <0.01**   |
| Stms-Stmi                     | 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; LS: Labrale superius; LI: Labrale inferius; Stms: Stomion superius; Sn: Subnasale; Stmi: Stomion inferius; Ils: Inferior labial sulcus

**Table 3: 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) |                       |                        |                   |         |         |
| Nasolabial 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)      |                       |                        |                   |         |         |
| Sul-sup-E line                | 6.79±1.12             | 7.64±1.55              | 0.15±1.29         | 0.48    | NS      |
| Sul-inf.-E line               | 5.86±1.66             | 4.00±2.19              | -1.86±2.25        | 2.24    | <0.05*  |
| 1 to LS                       | 10.64±2.73            | 11.21±4.07             | 0.57±4.43         | 1.33    | NS      |
| 1 to LI                       | 13.57±1.28            | 11.36±1.55             | -2.21±0.98        | 2.02    | <0.01** |
| Sn-Stms                       | 18.36±2.27            | 19.03±2.50             | 0.67±1.86         | 2.18    | <0.05*  |
| Stmi-ILS                      | 14.00±1.52            | 14.93±1.86             | 0.93±1.73         | 2.17    | <0.05*  |
| Stms-Stmi                     | 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; LS: Labrale superius; LI: Labrale inferius; Stms: Stomion superius; Sn: Subnasale; Stmi: Stomion inferius; Ils: Inferior labial sulcus

*et al.*<sup>[13]</sup> James<sup>[14]</sup> uses Merrifield's 'Z' angle to quantify and compare the pre-treatment and post-treatment profiles of the extraction and non-extraction groups used in their study and found an increase of about 6° in the value of 'Z' angle in extraction group. Finnoy *et al.*<sup>[13]</sup> observed 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 2.

Findings were also in accordance with Bravo<sup>[15]</sup> who revealed that sulcus superior and sulcus inferior moved back an average of 1.6 and 2.3 mm to E line respectively. The pre-treatment position and thickness of the lip as well as the initial maxillo-mandibular skeletal relationship may be predictors of post-treatment lip position suggesting changes in the lower facial profile.

Maxillary central incisor-LS (upper lip thickness) also increased 2.30 mm following treatment. Anderson *et al.*<sup>[16]</sup> reported a similar finding. Ricketts reported that upper lip thickened 1 mm with 3 mm of retraction of upper incisors.

Increase in vertical lip height, is observed in this group. Increase in upper lip height was about 1.92 mm while lower lip height increase was 1.46 mm that is supported by study of Abdel Kader.<sup>[17]</sup> He said vertical lip height increases with treatment but the increase is statistically insignificant at the one present level and it is significantly dependent on the reduction in over jet.

About 3 mm decrease in interlabial gap was found to be influenced uniformly by retraction of maxillary incisors. Jacobs<sup>[18]</sup> gave a similar finding and said that decrease in

**Table 4: Extraction versus non-extraction (intergroup comparison of changes in group 1 and group 2): Descriptive and inferential statistics of mean value differences: Soft-tissue analysis post-treatment result**

| Name of variables              | Extraction | Non-extraction | t value | P value |
|--------------------------------|------------|----------------|---------|---------|
| Angular variables (in degrees) |            |                |         |         |
| Nasolabial angle               | 6.84±8.56  | 1.14±4.54      | 2.18    | <0.05*  |
| Mentolabial angle              | 4.92±12.94 | 1.43±3.92      | 0.96    | NS      |
| Z angle                        | 4.00±3.53  | 0.92±3.54      | 2.26    | <0.05*  |
| N'-Sn-Pog'                     | 1.69±3.05  | 3.43±3.06      | 1.48    | NS      |
| Linear variables (in mm)       |            |                |         |         |
| Sul-sup-E line                 | 1.00±1.00  | 0.15±1.29      | 0.31    | NS      |
| Sul-inf.-E line                | 0.92±1.55  | -1.86±2.25     | 1.04    | NS      |
| 1 to LS                        | 2.30±2.14  | 0.57±4.43      | 1.28    | NS      |
| 1 to LI                        | 2.08±1.93  | -2.21±0.98     | 2.21    | <0.05*  |
| Sn-Stms                        | 1.92±1.50  | 0.67±1.86      | 3.58    | <0.01** |
| Stmi-Ils                       | 1.46±1.39  | 0.93±1.73      | 0.75    | NS      |
| Stms-Stmi                      | 3.00±4.29  | 1.14±1.82      | 1.76    | <0.05*  |

\*\*\* $P < 0.001$ : Highly significant; \*\* $P < 0.01$ : Significant; \* $P < 0.05$ : Just significant; NS $> 0.05$ : Non-significant; LS: Labrale superius; LI: Labrale inferius; Stms: Stomion superius; Sn: Subnasale; Stmi: Stomion inferius; Ils: Inferior labial sulcus

interlabial gap can be predicted by retraction and intrusion of maxillary incisors.

In non-extraction group [Figure 5] decrease in lower lip thickness was about 2 mm and this was due to protrusion of lower incisors. Change in vertical height of upper and lower lip was found to be statistically significant in this group. However, this is a matter of controversy and described previously.

Interlabial gap reduction was less significant. This finding is based on the facts that upper lip retraction occurred and lip strain was eliminated. Jacobs<sup>[18]</sup> and Talass *et al.*<sup>[12]</sup> also reported decrease in interlabial gap following retraction of maxillary incisors.

Prominence of lower lip was increased due to decrease in linear distance between -LI by about 1.86 mm, which is due to mild proclination of lower incisors in attempt to relieve the crowding in non-extraction group. Saelens and Smit<sup>[19]</sup> and Finnoy *et al.*<sup>[13]</sup> in their study found nasolabial angle was increased in extraction group, but the less pronounced mean increase in the non-extraction group was not significant same as in present study.

When comparison was made between extraction and non-extraction groups [Table 4, Figure 6] improvement in nose, lip, chin relationship depicted by increase in 'Z' angle is found to be more in extraction group (about 4°) than non-extraction group (0.92°). Findings are supported by James,<sup>[14]</sup> Saelens and Smit<sup>[19]</sup> and Finnoy *et al.*<sup>[13]</sup> who reported that non-extraction group completed treatment with a slightly more protrusive lip profile position than did the extraction group. Linear distance between mandibular incisor to mandibular incisor to LI was found to be increased in extraction group 2.08 mm,

while it decreases in non-extraction group (2.21 mm). Zierhut *et al.*<sup>[20]</sup> and noted greater lower lip retraction relative to the esthetic plane in the extraction sample of study. Caplan and Shivpuja<sup>[21]</sup> supported the present finding and found decrease in upper and lower lip thickness during non-extraction. When profile changes from pre-treatment to post-treatment were examined, significant differences in treatment-associated changes between extraction and non-extraction groups were all related to the lower lip and chin.<sup>[22]</sup> Bowman and Johnston concluded extraction treatment producing improved facial esthetics for those patients who present with some combination of crowding and protrusion.<sup>[23]</sup>

Increase in upper lip length (Sn-Stms) was found to be more in extraction group. Rains and Nanda<sup>[24]</sup> stated that upper lip response was related to both upper and lower incisor movement, mandibular rotation and lower lip. Burstone<sup>[25]</sup> and Hersery<sup>[26]</sup> 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 interlabial gap is also more pronounced in extraction group than non-extraction group. The variable is found to be influenced uniformly by a retraction of maxillary incisors. Jacobs<sup>[18]</sup> presented a similar finding and stated decrease in interlabial 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 framework. Yogosawa<sup>[27]</sup> stated when observing closure of the interlabial gap it is interesting to note that lower lip requires four times the upper lip movement.

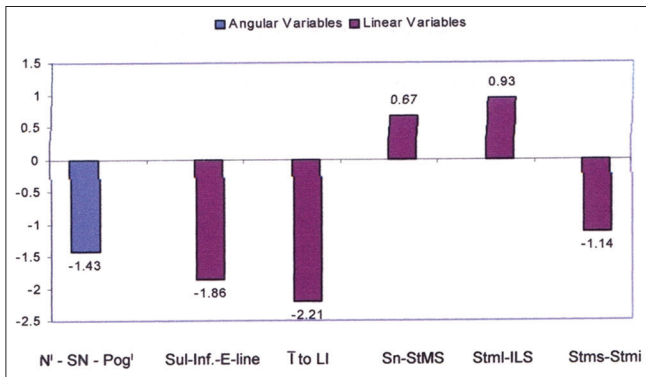
Although extraction mechanotherapy has often been associated with flattening of the facial profile, the results achieved in this



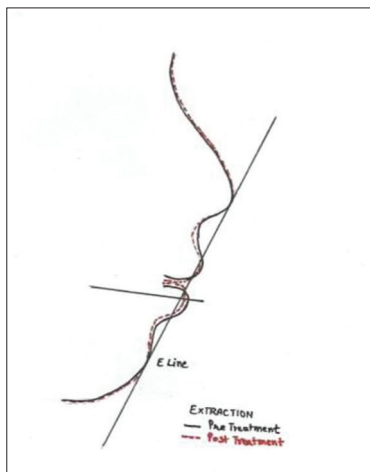
study showed no significant difference in lip position of premolar extraction patients when compared with those cases treated without extractions, signifying that both treatment modalities finished within the same soft-tissue parameters. Similar observations have been reported by different authors.<sup>[4,22,23,28]</sup>

Although the premolar extraction group showed greater soft-tissue changes with treatment, post-treatment comparisons showed that both groups finished within the same soft-tissue parameters.<sup>[29]</sup> The absence of significant differences between the changes in both groups could be explained by the small to moderate Class II malocclusion severity.<sup>[30]</sup>

Initial and post-treatment profiles for both groups were superimposed according to Rickett's method and found no significant difference in the post-treatment profiles [Figures 7 and 8]. According to Ricketts, a distance of  $-3.0$  mm to  $\pm 2.0$  mm from the lower lip to the E line should be considered normal in 15-year-olds. Most of patients started with satisfactory profile and after being treated with extractions or without extractions in order to enhance health and stability, the profiles were still satisfactory.



**Figure 5:** Significant post-treatment changes for soft-tissue variables in non-extraction group plotted on bar diagram

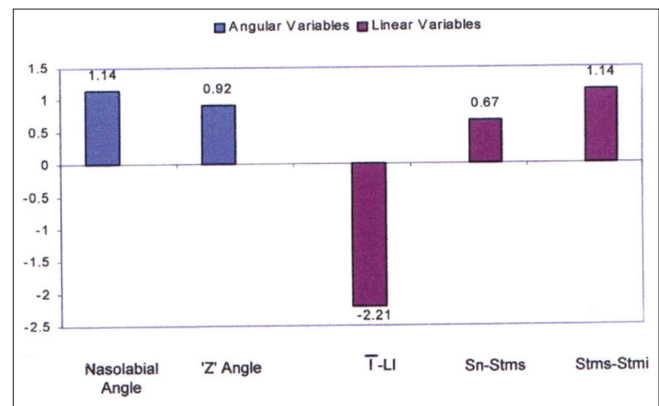


**Figure 7:** An example of the pre-treatment and post-treatment profile superimposition selected randomly from the extraction sample

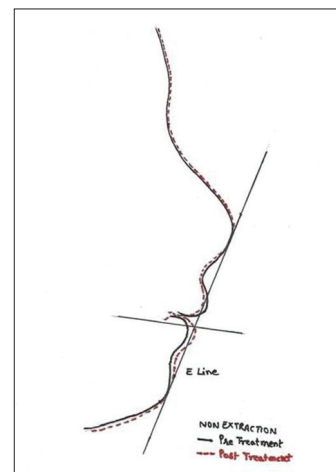
These comparisons suggest that the extraction or non-extraction decision, if based on sound diagnostic criteria, seem to have no systematic detrimental effects on the facial profile. Satisfactory results can be obtained consistently either by extracting premolar or without extracting them. Yet clinicians should be aware of the observed changes during treatment planning of individual patients to creating any undesirable esthetic characteristics. It also needs to be remembered that the clinician's judgment is influenced by other factors including the severity of tooth size-arch length discrepancies as well as the diagnostic, mechanical and esthetic biases of each orthodontist.

### Conclusion

1. Lip protrusion is an important pre-treatment profile characteristic that influences the extraction decision in addition to the presence of a tooth size-arch length discrepancy
2. After treatment, it was observed that (a) the soft-tissue convexities was straighter in extraction groups more than



**Figure 6:** Comparison of significant soft-tissue changes between extraction and non-extraction group plotted on bar diagram



**Figure 8:** An example of the pre-treatment and post-treatment profile superimposition selected randomly from the non-extraction sample

in the non-extraction groups; (b) the upper and lower lips were more retrusive in the extraction groups as compared to non-extraction groups. However, the mean finished profile assessment for both the groups fell within the pleasing normal range as measured by E line.

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**How to cite this article:** Verma SL, Sharma VP, Tandon P, Singh GP, Sachan K. Comparison of esthetic outcome after extraction or non-extraction orthodontic treatment in class II division 1 malocclusion patients. *Contemp Clin Dent* 2013;4:206-12.

**Source of Support:** Nil. **Conflict of Interest:** None declared.