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# A comparative evaluation of pre-treatment and post-treatment outcomes in patients subjected to lower incisor extraction

**Smruti Chandan Mohapatra**[1], **Ratna Parameswaran**[2], **Shilpa Mahapatra**[3]*

[1]*Dept. of Orthodontics and Dentofacial Orthopedics, Kalinga Institute of Dental Science, Bhubaneswar, Odisha, India*
[2]*Dept. of Orthodontics and Dentofacial Orthopedics, Meenakshi Ammal Dental College, Chennai, Tamil Nadu, India*
[3]*Dept. of Public Health Dentistry, Srirama Chandra Bhanja Dental College and Hospital, Cuttack, Odisha, India*

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ABSTRACT

**Introduction:** Mandibular incisor crowding is the most frequently occurring characteristic of malocclusion, which can be resolved by removing single lower incisor.
**Aim:** The aim of this study was to evaluate and compare the pre- and post-treatment outcomes through model and cephalometric analysis of the patients subjected to single lower incisor extraction.
**Materials and Methods:** In this retrospective study pre- and post-treatment lateral cephalograms and models of 23 patients who underwent fixed orthodontic treatment with single incisor extraction on lower arch were evaluated. The study subjects were classified into two groups based on extraction pattern (Group I: Upper premolar and lower single incisor extraction; Group II: Upper non extraction and lower single incisor extraction). Both cephalometric and model analysis were carried out using Ilexis FACAD AB-2014 Version3.8.0.0 (Ilexis AB, Sweden). Wilcoxon Signed Rank test was used to compare the pre and post-treatment quantitative parameters.
**Results:** A significant decrease was observed in the maxillary intermolar width, mandibular intercanine width, mandibular intermolar width, mandibular arch length and anterior Bolton's ratio. Group I subjects revealed a greater decrease in maxillary intermolar width compared to Group II, whereas a greater decrease in mandibular intercanine width, mandibular intermolar width and anterior Bolton's ratio was documented in Group II subjects compared to Group I. Cephalometric analysis revealed significant proclination and extrusion effect of lower incisors along with protrusive tendency of the lower lip.
**Conclusion:** The findings of the present study provide an additional option of extracting single lower incisor, in borderline or Class II camouflage treatment cases.



## 1. Introduction

In a diverse and vast country like India, a large variation in malocclusion exists, due to disparities in ethnicity, nutritional status and religious beliefs. The prevalence of Class II malocclusion in India has been reported as 4.9%.[1] In Class I and Class II malocclusion, crowding has been reported to be a more common feature compared to spacing, midline diastema, or crossbite. The need to correct them by camouflage technique has always been the choice of treatment.[2]

The philosophy of extraction as an aid in resolving arch length deficiencies in conjunction with orthodontic treatment is not new. While the clinicians have often debated the merits of an extraction versus a non-extraction approach, some patients are not deemed ideal candidates for either treatment option. This inconsistency in treatment planning mainly occurs when soft tissue is given primary focus.[3,4]

* *Corresponding author*.
*E-mail address*: doctor.shilpaa@gmail.com (S. Mahapatra).

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Treatment planning in borderline patients by premolar extraction often result in dishing in of the profile and premature aging of the face which challenge the modality of this treatment. Extraction of lower premolar in Class II malocclusion of mandibular deficiency might cause the lower lip to fall back, which would worsen the retrognathic facial profile. Current trends in treatment planning prefer fuller, more prominent lips for a youthful appearance.[5] When considering factors such as correction of crowding, minimum soft tissue drape, disadvantages of interproximal reduction, the extraction of a mandibular incisor can be opted as a treatment plan to achieve a stable occlusion with optimum esthetics.[6]

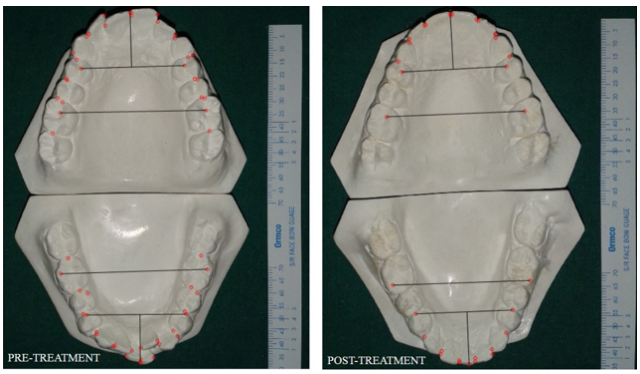


**Figure 1:** Model analysis of a pre-treatment and post-treatment cast

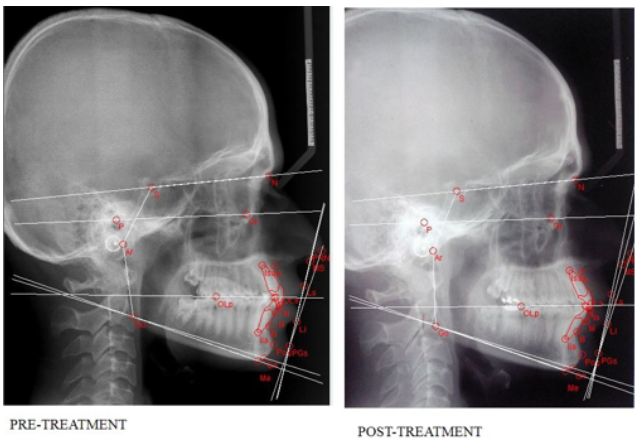


**Figure 2:** Cephalometric analysis of a pre-treatment and post-treatment lateral cephalogram

In a study conducted in an Indian population, the prevalence of crowding was documented as 58.12%.[2] Also when compared to other racial groups like Caucasoid, Mongoloid, Negroid, and Dominican, Indian population have larger anterior crown size, specifically lower anteriors.[7,8] Hence, single incisor extraction is a preferred option in this clinical scenario. The ethnic pattern in India projects diverse soft tissue probabilities which need to be evaluated pre- and post-orthodontic treatment. This study would help the clinicians to visualize the soft tissue changes and to achieve optimal and stable occlusion when lower single incisor extraction is chosen as a treatment option. The aim of this study was to compare the pre- and post-treatment outcomes through model and cephalometric analysis of the patients subjected to single lower incisor extraction.

## 2. Materials and Methods

The present study was retrospective in nature conducted in the Department of Orthodontics and Dentofacial Orthopedics, over a period of 14 months, August 2016 to October 2017. The nature and purpose of the study was explained to the Institutional Review Board and ethical clearance was acquired (MADC/IRB/2015/112). Consent forms were acquired from the study subjects for use of extracted teeth for study purpose.

### *2.1. Selection of study samples*

In this retrospective study, pre (T1) and post-treatment (T2) lateral cephalograms and models of 23 patients, aged 16-24 years, were collected. The patients who underwent fixed orthodontic treatment with pre-adjusted edgewise appliance (0.022 MBT prescription), with single lower incisor extraction, were included in the study. The sample consisted of dento-alveolar Class I and Class II on skeletal Class I or Class II base (evaluated by cephalometric values like SNA, SNB and ANB), with mandibular incisor crowding.

Initially, the study sample comprised of 30 cephalograms and models. However, 7 patients were excluded, 4 of them due to lack of pre- or post-treatment records and 3 had undergone lower premolar extraction along with single incisor extraction. Finally, the records of 23 patients were included in the study. The models were then stratified into two groups based on their extraction pattern. The groups were as follows:

### *2.2. Group I*

Group I (N=11) comprised of models of upper premolar and lower single incisor extraction.

### *2.3. Group II*

Group II (N=12) included upper non extraction and lower single incisor extraction.

### *2.4. Evaluation of the pre- and post-treatment records*

Overjet and overbite were measured using a digital vernier caliper. The casts were evaluated using photographs. The photographs of the pre- and post-treatment casts from an

**Table 1:** Comparison of pre-treatment (T1) and post-treatment (T2) model analysis parameters of Group I and II subjects

| Model Analysis Parameters | Group I (N=11) | | Group II (N=12) | | Total (N=23) | |
|---|---|---|---|---|---|---|
| | T2-T1 Mean ± SD (mm) | p-value | T2-T1 Mean ± SD (mm) | p-value | T2-T1 Mean ± SD (mm) | p-value |
| Mx I-C | 0.82 ± 2.24 | 0.16 | 0.95 ± 2.98 | 0.23 | 0.89 ± 2.59 | 0.09 |
| Mx I-M | -2.50 ± 2.29 | <0.001* | -1.75 ± 2.55 | 0.02* | -0.11 ± 2.40 | <0.001* |
| Mx Arch Length | -3.49 ± 4.33 | 0.04* | -0.08 ± 2.53 | 0.90 | -1.71 ± 3.84 | 0.09 |
| Md I-C | -1.01 ± 1.84 | 0.13 | -1.34 ± 2.52 | 0.05* | -1.18 ± 2.18 | 0.01* |
| Md I-M | -1.04 ± 1.42 | 0.03* | -1.24 ± 2.25 | 0.09 | -1.14 ± 1.86 | 0.01* |
| Md Arch Length | -1.34 ± 1.96 | 0.05* | -0.75 ± 1.67 | 0.15 | -1.03 ± 1.80 | 0.02* |
| Anterior Bolton's Ratio | -4.89 ± 4.38 | 0.01* | -5.14 ± 3.80 | <0.001* | -5.02 ± 3.99 | <0.001* |
| OJ | -5.08 ± 2.67 | <0.001* | -1.63 ± 0.72 | <0.001* | -3.28 ± 2.57 | <0.001* |
| OB | -2.24 ± 0.91 | <0.001* | -2.35 ± 1.52 | <0.001* | -2.30 ± 1.24 | <0.001* |

*Group I:* upper premolar and lower single incisor extraction. Group II: upper non extraction and lower single incisor extraction.
*Mx I-C:* Maxillary Intercanine Width, Mx I-M: Maxillary Intermolar Width, Mx Arch Length: Maxillary Arch Length.
*Md I-C:* Mandibular Intercanine Width, Md I-M: Mandibular Intermolar Width, Md Arch Length: Mandibular Arch Length.
*OJ: Overjet, OB:* Overbite.*denotes statistically significant; SD: Standard Deviation

**Table 2:** Comparison of pre-treatment (T1) and post-treatment (T2) lateral cephalometric analysis parameters of Group I and II subjects

| Parameters | Group I (N=11) | | Group II (N=12) | | Total (N=23) | |
|---|---|---|---|---|---|---|
| | T2-T1 Mean ± SD (mm) | p-value | T2-T1 Mean ± SD (mm) | p-value | T2-T1 Mean ± SD (mm) | p-value |
| IMPA ($^0$) | 1.52 ± 6.90 | 0.42 | 4.11 ± 5.36 | 0.01* | 2.87 ± 6.14 | 0.02* |
| Lower incisor to NB (mm) | 0.98 ± 1.47 | 0.04* | 1.60 ± 1.92 | 0.01* | 1.30 ± 1.71 | <0.001* |
| Lower incisor to NB ($^0$) | 3.64 ± 5.08 | 0.02* | 5.60 ± 6.22 | <0.001* | 4.66 ± 5.66 | <0.001* |
| Lower incisor to APog (mm) | 1.00 ± 1.75 | 0.05* | 2.22 ± 2.31 | <0.001* | 1.64 ± 2.11 | <0.001* |
| Lower incisor to APog ($^0$) | 4.54 ± 5.42 | 0.02* | 4.52 ± 5.51 | <0.001* | 4.53 ± 5.34 | <0.001* |
| Lower incisor to NPog (mm) | -0.44 ± 1.72 | 0.06 | -2.07 ± 2.00 | <0.001* | -1.29 ± 2.01 | <0.001* |
| Lower incisor to GoMe (mm) | 6.54 ± 3.46 | <0.001* | 2.18 ± 4.03 | 0.09 | 4.26 ± 4.30 | <0.001* |
| FMA ($^0$) | 0.50 ± 2.34 | 0.06 | 0.55 ± 2.60 | 0.63 | 0.53 ± 2.43 | 0.15 |
| Y-Axis | -0.15 ± 1.45 | 0.56 | -0.80 ± 0.90 | 0.01* | -0.49 ± 1.21 | 0.04* |
| Lower lip to E-Plane (mm) | 0.55 ± 2.14 | 0.37 | 0.40 ± 1.98 | 0.37 | 0.47 ± 2.01 | 0.22 |
| Lower lip to H-Line (mm) | 0.92 ± 1.81 | 0.10 | 0.58 ± 1.61 | 0.27 | 0.74 ± 1.68 | 0.05* |

Group I: upper premolar and lower single incisor extraction.
Group II: upper non extraction and lower single incisor extraction. *denotes statistically significant; SD: Standard Deviation.

occlusal view were captured using a digital camera (Nikon D5100), which was fixed at a focal length of 30 cm from the casts, using a tripod stand.[9] A ruler was placed adjacent to the cast for the image calibration. Both photographs of the cast (.jpeg format) and digital lateral cephalograms in the form of .jpeg format were then imported to the Ilexis FACAD AB-2014 Version 3.8.0.0 (Ilexis AB, Sweden) and calibrated.[10] After image calibration, digital models (Figure 1) and cephalograms (Figure 2) were analyzed using the same software.

### *2.5. Statistical analysis*

The data obtained were subjected to statistical analysis using Statistical Package for Social Science System, SPSS V. 22, IBM Chicago, to obtain the necessary information. Wilcoxon Signed Rank test was used to compare the pre and post-treatment quantitative parameters. A p-value of < 0.05 level of significance was used for all tests.

## 3. Results

The pre- and post-treatment model analysis parameters of the patients belonging to group I and II have been displayed in Table 1. A significant decrease in mandibular intercanine width, intermolar width, arch length, anterior Bolton's ratio, overjet and overbite was observed in both groups. Though, mandibular intercanine width in Group I, mandibular intermolar width and arch length in Group II revealed non-significant results, a decrease in these measurements was observed.

The comparison of pre- and post-treatment lateral cephalometric analysis parameters of both groups have been displayed in Table 2. A significant increase in proclination (lower incisor to NB and lower incisor to APog) and extrusion (lower incisor to GoMe) parameters of the lower incisor was observed in group I subjects. Whereas, the subjects in group II reported a statistically significant increase only in proclination parameters.

## 4. Discussion

The result of the current study revealed a significant reduction in the values of the maxillary inter-molar width in both groups owing to the mesial movement of upper molar. This was in accord with similar studies carried out by Bishara et al.[11] and Kim et al.[12] whereas, Gianelly[13] reported no change in the widths.

Group I subjects reflected significant results in relation to the maxillary arch length changes. These measurements were more reduced in Group I (3.49 ± 4.33 mm) compared to Group II (0.08 ± 2.53 mm) subjects. Maxillary arch length was measured from the midpoint between two central incisors to a line connecting the mesial contact points of first molar. As upper premolars were extracted in Group I patients it resulted in a greater decrease in the measurements. So, maxillary arch length also decreased in proportion to decrease in the maxillary intermolar width, owing to the upper premolar extraction. This result was in agreement with the results reported by Bishara et al.[11]

There was a significant decrease in the post-treatment values of mandibular intercanine width, which might be due to the mesial movement of the canine resulting in narrow intercanine area owing to the extraction of incisor. Similar results were obtained by Dacre,[14] Riedel et al.[3] and Faerovig and Zachrisson.[15] However, Faerovig and Zachrisson[15] reported a greater amount of reduction compared to the present study.

Mandibular intermolar width also revealed significant reduction in the post treatment values. Though Group II revealed greater reduction when compared to Group I subjects, the difference was statistically non-significant. Contradicting results were reported by Riedel et al.[3] who observed increased intermolar width after treatment, which decreased again in the same manner during postretention.

A significant decrease in post-treatment mandibular arch dimension was observed in all the study subjects. The decrease was greater in maxillary extraction group (Group I) compared to maxillary non-extraction (Group II). It was assumed that the lingual movement of the midpoint of the central incisor (due to closure of the lower single incisor extraction space) might have attributed to the decrease in the mandibular arch length. This result was in accordance with previous studies by Riedel et al.[3] and Faerovig and Zachrisson.[15]

Pre-treatment Anterior Bolton's Ratio revealed greater value than the average measurements i.e. 77.2%, which indicated that there was mandibular anterior excess at the start of the treatment. It was suggestive of removal of mandibular anterior tooth material for the proper fitting of anterior teeth, which can be treated in several ways like inter proximal reduction, removing any tooth such as incisor or restoration. By observing a number of disadvantages of inter proximal reduction (such as potential iatrogenic effects that include greater plaque retention, increased frequency of caries, periodontal disease, temperature sensitivity, susceptibility of proximal enamel surfaces to demineralization), lower anterior crowding along with Bolton's mandibular anterior excess, extraction of single lower incisor was advocated for all these subjects, even if some cases exhibited a very mild mandibular excess (anterior Bolton's ratio).

Few authors[16,17] have recommended interproximal reduction in upper anterior region after removal of one mandibular incisor to achieve proper upper and lower teeth coordination. In both the groups, post-treatment anterior Bolton's ratio displayed decreased value compared to the average ratio, i.e., 77.2% (Group I: 73.40 ± 5.02 and Group II: 74.01 ± 3.23). These reduced measurements suggestive of anterior maxillary teeth excess, which can be corrected through upper anterior interproximal reduction, as advocated by several authors such as Uribe and Nanda,[18] Singh and Ahluwalia,[16] and Simao et al.[17]

Both the groups reflected highly significant changes between pre- and post-treatment overjet and overbite measurements, which was reduced to nearly normal values. Similar result was documented by Riedel et al.[3] in their study.

A significant difference in the pre- and post-treatment measurements of the horizontal position of the lower incisor (IMPA, position of lower incisor to NB, APog, NPog; both linear and degree values) was observed, which revealed a significant proclination after single lower incisor extraction treatment. The degree of mandibular incisor proclination after the treatment was greater in maxillary extraction compared to maxillary non-extraction subjects. Since the patients had undergone camouflage treatment by extracting upper premolars and lower single incisor (because of increased overjet, Bolton's mandibular anterior

excess and lower anterior crowding), lower incisors were proclined to achieve proper anterior occlusion and overjet and to establish acceptable incisal stop. This result was in agreement with the studies conducted by Riedel et al.,[3] and Klein.[4] Contrary to the current study, few authors like Faerovig and Zachrisson,[15] and, Uribe and Nanda[18] reported post-treatment lingual tipping of the incisors. The common factor between these studies was that all their study subjects had class III malocclusion, which was generally camouflaged by retroclining the lower anteriors.

Measurements in the vertical position of the lower incisor (tip of the lower incisor to GoMe plane perpendicular to GoMe) revealed that, there was a significant increase in the post-treatment measurement, which exhibited that the lower incisors were extruded by the single lower extraction treatment plan. Maxillary extraction group signifies more amount of extrusion compared to non-extraction subjects. The probable cause for this type of increased extrusion could be the treatment mechanics employed. As those patients were camouflaged by removal of the upper premolars, the molar had to be finished in Class II relation at the end of treatment. Most of the time, advocating Class III elastics could be the reason for increased amount of incisor extrusion in these patients.

The protrusive tendency of lower lip might be attributed to the amount of lower incisor proclination. Yadav et al.[19] documented that the Indian population had an increased tendency for protrusive lips compared to that reported by Legan and Burstone[20] among the Caucasian population. A previous study by Klein,[4] has also documented about the protrusive nature of lower lip.

## 5. Conclusion

The present study revealed a significant decrease in mandibular intercanine width, maxillary intermolar width and arch length along with improvement in overjet and overbite. Furthermore, lower incisor exhibited proclination in the sagittal dimension and vertically, significant extrusion was reported. Lower incisor proclination resulted in protrusion of lower lip.

The findings of the present study provide an additional option for treating crowded lower dentition in borderline cases or class II camouflage treatment cases, where soft tissue profile might worsen after lower premolar extraction. The protrusive nature of the lower lip observed after the treatment could result in a youthful appearance which was preferred to the lower lip fall back observed in lower premolar extraction cases. Further studies need to be carried out to evaluate the long term stability of this treatment option. Thus, lower single incisor extraction paves the way to hasten the treatment duration which provide a stable and esthetic outcome in adult patients.

## 6. Source of Funding

None.

## 7. Conflict of Interest

None.

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## Author biography

**Smruti Chandan Mohapatra,** Senior Lecturer https://orcid.org/0000-0001-5026-0773

**Ratna Parameswaran,** Professor https://orcid.org/0000-0002-0652-4281

**Shilpa Mahapatra,** Assistant Professor https://orcid.org/0000-0001-7268-3531

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