*Original Article*

# Maxillary anterior alignment stability in Class I and Class II malocclusions treated with or without extraction

**William Juarez Granucci Guirro[a]; Karina Maria Salvatore Freitas[b]; Guilherme Janson[c]; Marcos Roberto de Freitas[c]; Camila Leite Quaglio[a]**

**ABSTRACT**

**Objective:** To compare the postretention stability of maxillary incisors alignment in subjects with Class I and II malocclusion treated with or without extractions.

**Materials and Methods:** The sample comprised 103 subjects with initial maxillary anterior irregularity greater than 3 mm and was divided into four groups: group 1 comprised 19 patients with Class I malocclusion treated with nonextraction (mean initial age = 13.06 years); group 2 comprised 19 patients with Class II malocclusion treated with nonextraction (mean initial age = 12.54 years); group 3 comprised 30 patients with Class I malocclusion treated with extractions (mean initial age = 13.16 years); group 4 comprised 35 patients with Class II malocclusion treated with extractions (mean initial age = 12.99 years). Dental casts were obtained at three different stages: pretreatment (T1), posttreatment (T2), and long-term posttreatment (T3). Maxillary incisor irregularity and arch dimensions were evaluated. Intergroup comparisons were performed by one-way analysis of variance followed by Tukey tests.

**Results:** In the long-term posttreatment period, relapse of maxillary crowding and arch dimensions was similar in all groups.

**Conclusion:** Changes in maxillary anterior alignment in Class I and Class II malocclusions treated with nonextractions and with extractions were similar in the long-term posttreatment period. (*Angle Orthod.* 2016;86:3–9.)

**KEY WORDS:** Relapse; Stability; Maxillary crowding



## INTRODUCTION

It is widely accepted that some occlusal changes after orthodontic treatment are inevitable.[1–4] Therefore, it would greatly benefit orthodontists to be able to accurately predict the likelihood of several occlusal changes occurring after treatment. For that reason, the effects of many diagnostic and treatment factors on short-term and long-term occlusal stability have been broadly investigated.[1,5–8]

A relatively small number of studies have evaluated the maxillary arch and parameters that may be helpful in predicting its long-term stability.[5,7–17] There are indications that the amount of maxillary incisor irregularity seen long term after retention is smaller than that seen before treatment,[11,15–17] and that rotational relapse of individual teeth hardly exceeds 20°.[11,17] Some studies have concluded that the amount of rotational relapse is proportional to the amount of orthodontic correction and that there may be an association between development of crowding and postretention reduction in arch length and width.[11,17]

Erdinc et al.[7] compared relapse of maxillary anterior crowding in patients treated with and without premolar extraction. The authors found no intergroup long-term significant differences in the amount of crowding relapse. Canuto et al.[8] evaluated the influence of rapid palatal expansion on stability of maxillary incisor alignment in nonextraction cases and found that the procedure had no influence on crowding relapse.

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Undoubtedly, attempts to establish predictors of maxillary crowding relapse are few. Regarding stability, there are considerable controversies in the literature about long-term posttreatment maxillary crowding relapse in different types of malocclusions (Class I and Class II).[15,18] Uhde et al.[15] found no significant differences in stability of maxillary anterior crowding treatment in subjects with Class I and Class II malocclusion treated with and without extractions. Kahl-Nieke et al.[19] stated that increased overbite and posttreatment residual Class II or III molar relationships were associated factors in the process of postretention increase in crowding and incisor irregularity. Ormiston et al.[18] suggested that subjects with Class II malocclusion are about twice as likely to be unstable long-term after treatment compared with subjects with Class I malocclusion.

Based on the reported controversies and because of the scarce attempts to establish predictors of maxillary crowding relapse, we decided to investigate long-term changes in maxillary incisors of orthodontically treated patients with pretreatment Class I and Class II malocclusions treated with and without extractions. Therefore, our objective was to test the following null hypothesis by comparing four matched groups: changes in maxillary anterior alignment in subjects with Class I and Class II malocclusions treated with and without extractions are similar in the long-term posttreatment period.

## MATERIALS AND METHODS

### Material

This study was approved by the Ethics in Research Committee of Bauru Dental School, University of São Paulo, São Paulo, Brazil, and all subjects signed informed consent.

The sample size was calculated based on an alpha significance level of 0.05 and a beta of 0.2 to achieve 80% of power to detect a mean difference of 1.28 mm with a standard deviation of 1.38 mm in maxillary irregularity index change between the posttreatment and long-term posttreatment stages.[8] The sample-size calculation showed that 19 patients were needed.

The sample was obtained from the files of the Orthodontic Department at Bauru Dental School and consisted of 309 dental casts of 103 patients with Class I and Class II malocclusion treated with extraction and nonextraction. Dental casts were obtained at three different time points: pretreatment (T1), posttreatment (T2), and at a mean of 8.9 years long-term posttreatment (T3).

Besides availability of dental casts, other inclusion criteria were clinical records that described sex, pretreatment and posttreatment ages, length of treatment, length of retention, and long-term posttreatment time. Pretreatment dental casts should exhibit more than 3 mm of maxillary incisor irregularity.

At the end of active treatment, all patients wore a modified Hawley retainer in the maxillary arch, full-time during the first 6 months and during sleeping hours in the subsequent 6 months. A lingual canine to canine mandibular bonded retainer was installed and left for a mean period of 3 years.

The sample was divided into four groups according to the pretreatment type of malocclusion and presence of extractions.

#### Group 1: Patients With Class I Malocclusion and Nonextraction (CL I nonext)

Group 1 consisted of 57 dental casts of 19 patients with Class I malocclusion (12 female, 7 male) who underwent nonextraction orthodontic treatment at a mean initial age of 13.06 years (standard deviation [SD] = 1.27). These patients were treated for a mean period of 2.13 years (SD = 0.92) and concluded treatment at a mean age of 15.19 years (SD = 1.24). The mean time of long-term posttreatment evaluation was 7.52 years (SD = 1.56), and the age at this long-term evaluation was 22.72 years (SD = 2.29).

#### Group 2: Patients With Class II Malocclusion and Nonextraction (CL II nonext)

Group 2 comprised 57 dental casts of 19 patients with Class II malocclusion (14 female, 5 male) submitted to nonextraction orthodontic treatment, presenting at least 3/4 Class II molar anteroposterior relationship on both sides.[20,21] The mean initial age was 12.54 years (SD = 1.37). These patients were treated for a mean period of 2.38 years (SD = 0.71) and concluded treatment at a mean age of 14.93 years (SD = 1.50). The mean time of long-term posttreatment evaluation was 7.31 years (SD = 2.01), and the age at this long-term evaluation was 22.24 years (SD = 2.38).

#### Group 3: Patients With Class I Malocclusion and Extraction (CL I ext)

Group 3 comprised 90 dental casts of 30 patients with Class I malocclusion (18 female, 12 male) submitted to four premolar extraction treatment. The mean initial age was 13.16 years (SD = 0.97). These patients were treated for a mean period of 1.98 years (SD = 0.51) and concluded treatment at a mean age of 15.15 years (SD = 1.14). The mean time of long-term posttreatment evaluation was 8.55 years (SD = 3.03), and the age at this long-term evaluation was 23.70 years (SD = 2.79).

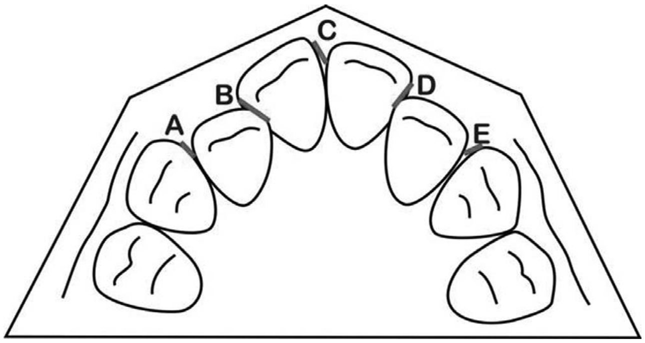


**Figure 1.** Maxillary incisor irregularity index[8,20,22] = A + B + C + D + E.

### Group 4: Patients With Class II Malocclusion and Extraction (CL II ext)

Group 4 comprised 105 dental casts of 35 patients with Class I malocclusion (18 female, 22 male) submitted to two (17 subjects) or four (18 subjects) premolar extraction treatment. The mean initial age was 12.99 years (SD = 1.03). These patients were treated for a mean period of 2.34 years (SD = 0.63) and concluded treatment at a mean age of 15.33 years (SD = 1.15). The mean time of long-term posttreatment evaluation was 8.65 years (SD = 2.19), and the age at this long-term evaluation was 23.99 years (SD = 1.96).

### Methods

Pretreatment, posttreatment, and long-term posttreatment maxillary dental casts were used. All dental cast measurements were made with a precision digital caliper (Mitutoyo America, Aurora, Ill). The assessed variables were maxillary irregularity index, arch length, and intercanine, interpremolar, and intermolar widths (Figures 1 and 2).

### Dental Arch Measurements

Maxillary dental casts were measured by one investigator to the nearest 0.01 mm with the digital caliper. Landmarks used were the cusp tips of the canines, the central fossae of the maxillary second premolars, and the mesial buccal cusps of the first molars of each patient. In cases where a facet existed, the cusp tip was estimated.[10] Measurements were blindly randomly performed for all patients. All were linear measurements, described as follows:

—Maxillary incisors irregularity index (Little index[8,22]): The sum, in millimeters, of the five distances between the anatomic contacts from the mesial aspect of the right canine through the mesial aspect of the left canine, which is similar to Little's method to evaluate mandibular incisor irregularity[23] (Figure 1).

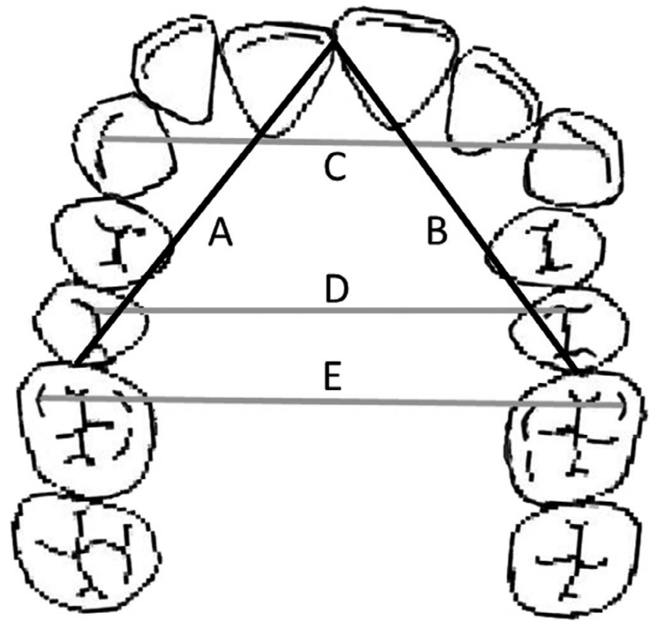


**Figure 2.** Variables studied in dental casts. A + B, arch length; C, 3-3 width; D, 5-5 width; E, 6-6 width.

—Arch length (mm) – linear distance along the midline from the interincisal midline to the mesial contact of the first molars (Figure 2).

—3-3 width (intercanine width in millimeters) – linear distance between the cusp tips of the maxillary canines (Figure 2).

—5-5 width (inter-second premolar width in millimeters) – linear distance between the central fossae of the maxillary second premolars (Figure 2).

—6-6 width (intermolar width in millimeters) – linear distance between mesiobuccal cusps tips of the maxillary first molars (Figure 2).

### Error Study

Within a month's time from the first measurement, 30 dental casts were randomly selected and remeasured by the same examiner. Random errors were calculated according to Dahlberg's formula ($Se^2 = \Sigma d^2/2n$), where Se is the error variance and $d$ is the difference between two determinations of the same variable.[24] Systematic errors were evaluated with dependent $t$-tests, for $P < .05$.[25]

### Statistical Analyses

Normal distribution was verified by Kolmogorov-Smirnov tests. Intergroup comparability evaluation regarding pretreatment, posttreatment, and long-term posttreatment ages; treatment time; long-term posttreatment time; and pretreatment incisor irregularity index were calculated with one-way analysis of

**Table 1.** Intergroup Comparability Evaluation Regarding Ages at T1 (Pretreatment) and T2 (Posttreatment), Treatment Time, Long-Term Posttreatment Time and Initial Maxillary Incisor Irregularity (Analysis of Variance)[a]

| Variables | Group 1 (Class I Nonextraction, N = 19) | | Group 2 (Class II Nonextraction, N = 19) | | Group 3 (Class I Extraction, N = 30) | | Group 4 (Class II Extraction, N = 35 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | *P* |
| Pretreatment age, y | 13.06 | 1.27 | 12.54 | 1.37 | 13.16 | 0.97 | 12.99 | 1.03 | .300 |
| Posttreatment age, y | 15.19 | 1.24 | 14.93 | 1.50 | 15.15 | 1.14 | 15.33 | 1.15 | .714 |
| Long-term posttreatment age, y | 22.72 | 2.29 | 22.24 | 2.38 | 23.70 | 2.79 | 23.99 | 1.96 | .058 |
| Treatment time, y | 2.13 | 0.92 | 2.38 | 0.71 | 1.98 | 0.51 | 2.34 | 0.63 | .115 |
| Long-term posttreatment time, y | 7.52 | 1.56 | 7.31 | 2.01 | 8.55 | 3.03 | 8.65 | 2.19 | .108 |
| Initial irregularity, mm | 7.83 | 3.14 | 6.77 | 2.38 | 8.58 | 3.07 | 8.77 | 2.60 | .072 |

[a] SD indicates standard deviation.

variance (ANOVA). Sex distribution comparability among the groups was assessed with a $\chi^2$ test.

Means and standard deviations were calculated for all variables at the initial, final, and long-term posttreatment stages for each group. Treatment changes were also evaluated and calculated by subtracting the initial from the final values (T2-T1). The amount of relapse was calculated by subtracting the final from the long-term posttreatment values (T3-T2). Intergroup comparisons at the several stages and observation periods were performed with one-way ANOVA, followed by Tukey tests when necessary.

Results were considered significant at $P < .05$. All statistical analyses were performed with Statistica software (Statistica for Windows, Release 7.0, Statsoft, Inc, Tulsa, Okla, USA).

## RESULTS

Random errors ranged from 0.01 (Little index) to 0.65 mm (arch length). There were no statistically significant systematic errors.

The groups were comparable regarding pretreatment, posttreatment, and long-term posttreatment ages; treatment time; long-term posttreatment time; initial incisor irregularity; sex distribution; and maxillary arch dimensions (Tables 1 through 3).

The CL I and II nonext groups showed greater arch length as well as premolar and molar widths at the posttreatment and long-term posttreatment stages (T2 and T3) than the CL I and II ext groups (Table 3). At the long-term posttreatment stage, Little's maxillary irregularity in the CL I nonext group was significantly greater than that of the CL II nonext group (Table 3).

**Table 2.** Intergroup Comparison of Sex Distribution ($\chi^2$ Test)[a]

| Group | Female | Male | Total |
|---|---|---|---|
| Group 1 (Class I nonextraction) | 12 | 7 | 19 |
| Group 2 (Class II nonextraction) | 14 | 5 | 19 |
| Group 3 (Class I extraction) | 18 | 12 | 30 |
| Group 4 (Class II extraction) | 15 | 20 | 35 |
| Total | 59 | 44 | 103 |

[a] $\chi^2 = 5.42$; degrees of freedom = 3; $P = .143$.

During treatment there were increases in arch length as well as premolar and molar widths in the CL I and II nonext groups, and there were decreases in these variables in the CL I and II ext groups (Table 4). Therefore, there were significant differences between the nonextraction and extraction groups regarding the treatment changes in these variables.

Long-term posttreatment changes of maxillary irregularity and arch dimensions were similar in the four groups (Table 4).

## DISCUSSION

The groups were similar regarding several parameters that could influence this comparison. Results showed that pretreatment, posttreatment, and long-term posttreatment ages; treatment time; long-term posttreatment time; and initial maxillary incisor irregularity matched among the groups. Besides, the groups had comparable sex distribution and received the same retention protocol (Tables 1 and 2).

At pretreatment, none of the variables showed significant differences among the groups (Table 3). As previously mentioned, the initial maxillary crowding severity was matched, which allowed a reliable comparative evaluation of the long-term posttreatment changes. A study that evaluated crowding relapse during long-term posttreatment mentioned that pretreatment irregularity was directly related to the amount of relapse,[26] although another has not observed this correlation.[27]

Maxillary anterior crowding (Little index) was similar among the groups at the pretreatment and posttreatment stages (Table 3) and showed similar changes during treatment (T2-T1) and in the long-term posttreatment (T3-T2) period (Table 4). However, at the long-term posttreatment stage (T3), the CL I nonext group had significantly greater maxillary anterior crowding than the CL II nonext group (Table 3). This

**Table 3.** Intergroup Comparison of Maxillary Incisor Irregularity and Arch Dimensions at Pretreatment (T1), Posttreatment (T2), and Long-Term Posttreatment (T3) Stages (Analysis of Variance Followed by Tukey Tests)[a,b]

| | Group 1 (Class I Nonextraction, N = 19) | | Group 2 (Class II Nonextraction, N = 19) | | Group 3 (Class I Extraction, N = 30) | | Group 4 (Class II Extraction, N = 35) | | |
|---|---|---|---|---|---|---|---|---|---|
| Variables (mm) | Mean | SD | Mean | SD | Mean | SD | Mean | SD | $P$ |
| Pretreatment (T1) | | | | | | | | | |
| Little | 7.83 | 3.14 | 6.77 | 2.38 | 8.58 | 3.07 | 8.77 | 2.60 | .072 |
| Arch length | 68.33 | 4.72 | 68.59 | 3.46 | 71.03 | 3.78 | 70.74 | 3.75 | .050 |
| 3-3 width | 33.79 | 2.36 | 33.35 | 2.71 | 34.78 | 2.25 | 34.51 | 3.03 | .237 |
| 5-5 width | 37.91 | 2.94 | 37.32 | 2.51 | 37.87 | 2.17 | 37.31 | 2.37 | .711 |
| 6-6 width | 49.49 | 3.16 | 49.71 | 2.66 | 49.31 | 2.79 | 49.13 | 2.52 | .898 |
| Posttreatment (T2) | | | | | | | | | |
| Little | 0.51 | 0.67 | 0.29 | 0.43 | 0.79 | 0.89 | 0.60 | 0.52 | .080 |
| Arch length | 71.01[A] | 3.45 | 71.21[A] | 3.75 | 62.04[B] | 2.20 | 61.69[B] | 3.12 | .000* |
| 3-3 width | 34.46 | 1.48 | 34.42 | 1.86 | 34.73 | 1.75 | 35.09 | 1.88 | .488 |
| 5-5 width | 40.90[A] | 2.19 | 39.93[A] | 2.34 | 36.30[B] | 1.76 | 36.53[B] | 1.74 | .000* |
| 6-6 width | 51.53[A] | 2.86 | 50.61[A] | 3.04 | 47.78[B] | 2.32 | 47.33[B] | 2.65 | .000* |
| Long-term posttreatment (T3) | | | | | | | | | |
| Little | 2.01[A] | 1.87 | 0.80[B] | 0.76 | 1.78[AB] | 1.58 | 1.67[AB] | 1.17 | .041* |
| Arch length | 69.48[A] | 3.38 | 70.06[A] | 3.19 | 60.66[B] | 2.26 | 60.30[B] | 3.15 | .000* |
| 3-3 width | 34.29 | 1.47 | 34.24 | 2.06 | 34.57 | 1.58 | 34.91 | 2.17 | .549 |
| 5-5 width | 40.20[A] | 2.04 | 39.23[A] | 2.07 | 35.27[B] | 2.05 | 35.58[B] | 2.18 | .000* |
| 6-6 width | 51.34[A] | 2.69 | 50.72[A] | 2.88 | 47.12[B] | 2.76 | 47.11[B] | 2.81 | .000* |

[a] Different letters indicate statistically significant differences.
[b] SD indicates standard deviation.
* Statistically significant at $P < .05$.

could be probably consequent to the greater, although nonsignificant, maxillary crowding that the CL I nonext group presented in relation to the CL II nonext group at the pretreatment and posttreatment stages.

These results do not corroborate the previous study by Ormiston et al.,[18] which suggested that treated Class II malocclusions are more unstable than Class I malocclusions. Uhde et al.[15] found no significant differences in stability of maxillary anterior crowding treatment in patients with Class I and Class II malocclusions, as was found in the present study. Another study also found no difference in maxillary anterior crowding relapse in extraction and nonextraction cases.[7]

At the posttreatment (T2) and long-term posttreatment (T3) stages, arch length, interpremolar widths,

**Table 4.** Intergroup Comparison of Maxillary Incisor Irregularity and Arch Dimensions for the Treatment (T2-T1) and Long-Term Posttreatment Changes (T3-T2) (Analysis of Variance Followed by Tukey Tests)[a,b]

| | Group 1 (Class I Nonextraction, N = 19) | | Group 2 (Class II Nonextraction, N = 19) | | Group 3 (Class I Extraction, N = 30) | | Group 4 (Class II Extraction, N = 35) | | |
|---|---|---|---|---|---|---|---|---|---|
| Variables (mm) | Mean | SD | Mean | SD | Mean | SD | Mean | SD | $P$ |
| Treatment changes (T2-T1) | | | | | | | | | |
| Little | −7.32 | 3.04 | −6.48 | 2.25 | −7.79 | 2.88 | −8.16 | 2.50 | .165 |
| Arch length | 2.68[A] | 3.18 | 2.61[A] | 3.01 | −8.99[B] | 3.10 | −9.04[B] | 3.59 | .000* |
| 3-3 width | 0.56 | 2.67 | 1.06 | 2.07 | −0.05 | 2.05 | 0.57 | 2.26 | .390 |
| 5-5 width | 2.98[A] | 2.27 | 2.60[A] | 2.69 | −1.56[B] | 1.85 | −0.78[B] | 1.98 | .000* |
| 6-6 width | 2.03[A] | 2.13 | 0.90[A] | 2.78 | −1.52[B] | 2.13 | −1.80[B] | 2.44 | .000* |
| Long-term posttreatment changes (T3-T2) | | | | | | | | | |
| Little | 1.50 | 1.60 | 0.50 | 0.75 | 0.98 | 1.26 | 1.06 | 1.27 | .118 |
| Arch length | −1.53 | 0.75 | −1.15 | 1.39 | −1.38 | 1.36 | −1.39 | 1.41 | .835 |
| 3-3 width | −0.16 | 0.89 | −0.17 | 0.77 | −0.15 | 1.01 | −0.18 | 1.31 | .999 |
| 5-5 width | −0.85 | 0.97 | −0.70 | 1.21 | −1.02 | 0.97 | −0.94 | 1.32 | .803 |
| 6-6 width | −0.18 | 0.90 | 0.10 | 0.99 | −0.66 | 1.28 | −0.21 | 1.80 | .280 |

[a] Different letters indicate statistically significant differences.
[b] SD indicates standard deviation.
* Statistically significant at $P < .05$.

and intermolar widths were found to be wider in the nonextraction than in the extraction groups (Table 3). During treatment there was an increase in arch length, interpremolar widths, and intermolar widths in the nonextraction groups and a decrease of these variables in the extraction groups (Table 4). This was already expected, as extraction decreases the arch length and posterior widths of the dental arches.[7,28]

Long-term posttreatment changes of maxillary anterior alignment (Little index) and arch dimensions were similar in the groups (Table 4). Erdinc et al.[7] also found no difference in maxillary anterior crowding relapse and arch dimensions posttreatment changes between extraction and nonextraction cases. Maxillary anterior alignment showed greater stability than the current study, but the initial maxillary crowding of their sample was smaller than ours.

Some relapse of maxillary anterior crowding occurred in most patients, with mean percentages of 20.49%, 7.71%, 12.58%, and 12.99% for the CL I nonext, CL II nonext, CL I ext, and CL II ext groups, respectively. The amount of maxillary anterior crowding relapse is considered to be small to moderate by Little.[22] Nevertheless, in this study, it was greater than in previous reports.[9,10,29,30] The greater relapse was probably because the patients in the present study had a relatively shorter retention period with the Hawley plate. Other studies did not report the retention protocol after treatment.[31,32] This suggests that, similar to the mandibular arch, a prolonged retention time might be important for long-term stability.[9,33] However, the most important part of a stability study is to evaluate the posttreatment changes after some time without artificial retention.

The patients did not undergo circumferential supracrestal fiberotomy procedures. This could help in preventing rotational relapse. The circumferential supracrestal fiberotomy surgical procedure seems to alleviate pure rotational relapse more than labiolingual relapse, and it is more successful in reducing relapse in the maxillary anterior segment than in the mandibular anterior segment.[34]

The success of orthodontic treatment is judged by the long-term stability of the results. In this study, both Class I and Class II extraction and nonextraction treatments showed a good and similar stability of maxillary teeth alignment.

## CONCLUSION

- The null hypothesis could not be rejected. The changes in maxillary anterior alignment in patients with Class I and Class II malocclusions treated with and without extractions were not significantly different in the long-term posttreatment period.

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