# Comparative cephalometric study of Class II malocclusion treatment with Pendulum and Jones jig appliances followed by fixed corrective orthodontics

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**Objective:** The purpose of this study was to cephalometrically compare the skeletal and dentoalveolar effects in the treatment of Class II malocclusion with Pendulum and Jones jig appliances, followed by fixed corrective orthodontics, and to compare such effects to a control group.

**Methods:** The sample was divided into three groups. Group 1: 18 patients treated with Pendulum, Group 2: 25 patients treated with Jones jig, and Group 3: 19 young subjects with untreated Class II malocclusions and initial mean age of 12.88 years. The chi-square test was applied to assess severity and gender distribution. Groups 1 and 2 were compared to the control group by means of the one-way ANOVA and Tukey tests in order to differentiate treatment changes from those occurred by craniofacial growth.

**Results:** There were no significant changes among the three groups with regard to the components of the maxilla and the mandible, maxillomandibular relationship, cephalometric and tegumental pattern. Buccal tipping of mandibular incisors was significantly greater in the experimental groups and increased mesial angulation of the maxillary second molars was found in the Jones jig group. In the experimental groups, dental relationship, overbite and overjet were corrected.

**Conclusion:** It can be stated that the distalization achieved its purpose of correcting the Class II.

**Keywords:** Angle Class II malocclusion. Corrective orthodontics. Molar tooth.

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## INTRODUCTION

Intraoral distalizers differ in terms of insertion site,[4] mechanism of action and anchorage reinforcement.[15] The Jones jig appliance is inserted buccally and acts through a nickel titanium spring anchored in the second premolars.[14] The Pendulum appliance is palatally positioned, anchored in the first and second premolars and its force is dissipated through TMA springs.[12]

The intraoral distalization performed with fixed intraoral devices is only the first phase of a treatment that will be finalized with fixed corrective mechanics. There are few studies in the literature that scientifically assess the results of both phases of treatment;[3,6,7,20] most studies only assess the results of distalization.[9,10,12,15,16,17,21] Therefore, it is essential to perform a study assessing and comparing the results of corrective orthodontic treatment initiated by intraoral maxillary molar distalization with different intraoral distalization appliances.

## MATERIAL AND METHODS

Initially, the research project was evaluated and approved by the College of Dentistry – Bauru/ University of São Paulo (USP) Institutional Review Board .

Three groups with Class II malocclusion were compared: Group 1: comprised 18 patients (initial mean age of 13.92 years), 6 males and 12 females. A normal molar relationship was obtained from maxillary molar distalization performed with the Pendulum appliance and maintained by the nightly use of cervical headgear (KHG) associated with corrective fixed appliances. The mean treatment time was 4.55 years (Table 1). Group 2: comprised 25 patients (initial mean age of 12.09 years), 14 males and 11 females. Class II correction was achieved with the Jones jig appliance and maintained by the nightly use of medium-high headgear traction (helmet jeans), during corrective orthodontic treatment. The mean duration of orthodontic treatment was 4.09 years (Table 1).

Group 3: comprised 19 young subjects with untreated Class II malocclusion (control group), 10 males and 9 females (initial mean age of 12.88 years) and followed up for a mean period of 3.71 years (Table 1). This sample was selected from a group of young subjects that had been annually radiographed and accompanied by the Department of Orthodontics, School of Dentistry – Bauru/ University of São Paulo (USP). All patients had been referred for orthodontic treatment, however, some of them opted for late intervention and others had no interest in the treatment.

The cephalometric variables analyzed were based on the orthodontic literature[3,6,8,11,22] and aimed at promoting a comparative study, allowing discussion of the results obtained (Fig 1).

At first, chi-square tests were used to assess severity and gender distribution (Tables 2 and 3). The three groups were assessed and cephalometrically compared in order to observe the effects of orthodontic treatment and to differentiate them in terms of the changes promoted by craniofacial growth and development (Fig 1). Thus, one-way ANOVA and Tukey tests were used.

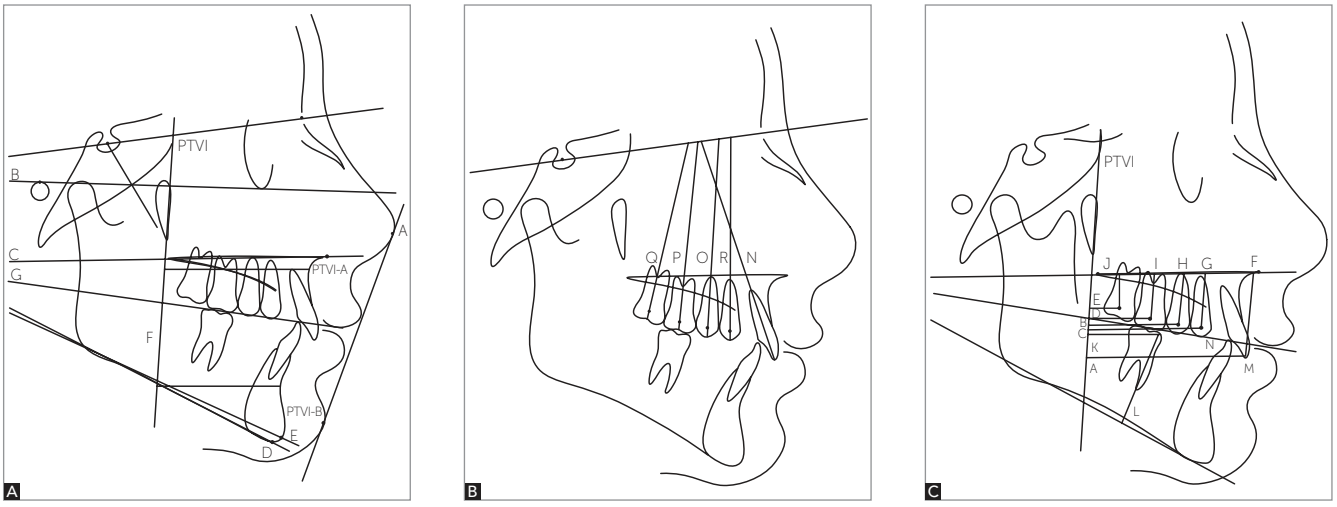


**Figure 1** - **A**) Lines and Planes: A = Line E; B = Frankfort Plane; C = Palatal Plane; D = Mandibular Plane (Go-Me); E = Mandibular Plane (Go-Gn); F = Pterygoid vertical line (PTVI); G = Occlusal Plane; **B)** Dental angular measurements: N = SN.1; R = SN.4; O = SN.5; P = SN.6; Q = SN.7. **C)** Dental linear measurements: A = PTVI-1; B = PTVI-4; C = PTVI-5; D = PTVI-6; E = PTVI-7; F, = PP-1; G, = PP-4; H = PP-5; I = PP-6; J = PP-7; K = PTVI- ; L = GoMe - , M = Overjet; N = Overbite.

**Table 1** - Compatibility of the mean initial and final ages as well as the observation mean time of the young patients in the three groups (ANOVA).

| VARIABLE (Y) | Group 1 (Pendulum) N = 18 | | Group 2 (Jones jig) N = 25 | | Group 3 (Control) N = 19 | | P |
|---|---|---|---|---|---|---|---|
| | Mean ± SD | | Mean ± SD | | Mean ± SD | | |
| Pretreatment age | 13.92[A] | 1.71 | 12.90[A] | 1.43 | 12.88[A] | 1.47 | 0.063 |
| Posttreatment age | 18.48[A] | 1.33 | 16.99[B] | 1.87 | 16.60[B] | 2.31 | 0.008* |
| Observation time ($T_3$ -$T_1$) | 4.55[A] | 0.79 | 4.09[A] | 0.99 | 3.71[A] | 1.63 | 0.110 |

* Statistically significant for P < 0.05
Different letters stand for statistically significant difference.

**Table 2** - Number of female and male subjects for each group and result of the chi-square test.

| Group | Sex | | Total |
|---|---|---|---|
| | Male | Female | |
| 1 – Pendulum | 6 (33.3%) | 12 (66.7%) | 18 |
| 2 – Jones jig | 14 (56%) | 11 (44%) | 25 |
| 3 – Control | 10 (52.6%) | 9 (47.4%) | 19 |
| Total | 30 | 32 | 62 |
| $\chi^2$ = 2.35; gl = 2; P = 0.3087 | | | |

* Statistically significant difference for P < 0.05
Different letters stand for statistically significant difference.

**Table 3** - Comparison of Class II malocclusion severity among groups and chi-square test results.

| Group | Molar relationship | | | | Total |
|---|---|---|---|---|---|
| | ¼ Class II | ½ Class II | ¾ Class II | Full-cusp Class II | |
| 1 – Pendulum | 1 (5.6%) | 7 (38.8%) | 5 (27.8%) | 5 (27.8%) | 18 |
| 2 – Jones jig | 11 (44%) | 7 (28%) | 3 (12%) | 4 (16%) | 25 |
| 3 – Control | 9 (47.4%) | 5 (26.3%) | 3 (15.8%) | 2 (10.5%) | 19 |
| Total | 21 | 19 | 11 | 11 | 62 |
| $\chi^2$ = 9.76; gl=6; P = 0.1350 | | | | | |

* Statistically significant difference for P < 0.05
Different letters stand for statistically significant difference.

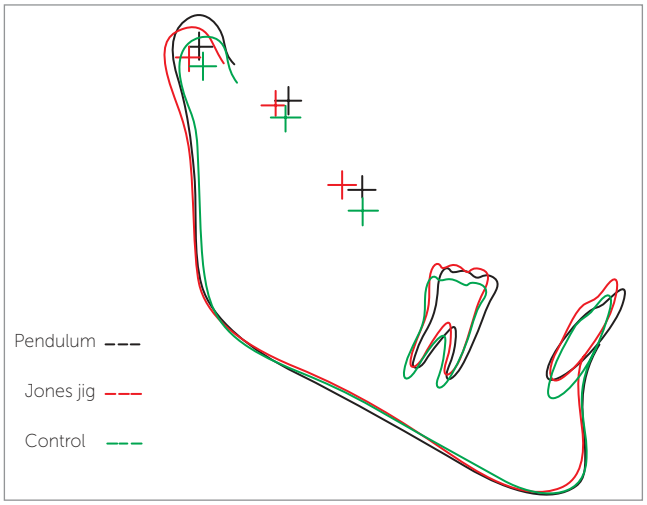


**Figure 2** - Comparison between Pendulum and Jones jig appliances and the control group.

## RESULTS

Initially, the groups were compared in order to quantify any potential differences existing prior to orthodontic treatment. Out of the 43 variables analyzed, only 10 presented statistically significant differences, demonstrating that the sample had approximately 77% of initial cephalometric compatibility (Table 4).

Changes during treatment as well as changes occurring during the growth and development period were obtained by means of establishing the difference between treated patients' initial and final mean values. Table 4 shows the results of one-way ANOVA and Tukey tests performed among the initial cephalometric measurements mean values of the three groups.

The components related to the maxilla, mandible, maxillomandibular relationship, vertical pattern and soft tissue did not present statistically significant differences (Table 5).

Greater mesial movement of maxillary second molars was observed in the Jones jig group. Buccal tipping of mandibular incisors was greater in the Pendulum group than in the control group. Additionally, greater protrusion of these incisors was observed in the experimental groups (Fig 2). The mandibular first molars showed similar mesial movement for all the three groups; however, greater extrusion was observed in the Jones jig group when compared to the Pendulum and control groups (Table 5).

There was a significant difference in molar relationship, with a significant change for the experimental groups, which resulted in correction of the Class II. Conversely, the initial malocclusion remained in the control group (Table 5).

## DISCUSSION

There are few comparatives studies assessing the first (maxillary molars distalization) and the second phase of treatment (corrective orthodontic treatment).[3,6,7,8] Thus, the aim of this study was to compare the changes at the end of the corrective orthodontic treatment, which was initialized by the distalization of the maxillary molars by two different intraoral distalization appliances. Additionally, it compared such changes to the control group.

Assessment of the characteristics related to the groups proved that there was compatibility in terms of initial age and treatment/observation times. On the other hand, the final age was statistically and

**Table 4** - ANOVA and Tukey test results: means and standard deviation of initial cephalometric measurements mean values taken to assess compatibility among groups as well as values of the significance probability level (P) - ($T_1$).

| Variable | Group 1 (Pendulum) n = 18 | Group 2 (Jones Jig) n = 25 | Group 3 (Control) n= 19 | p |
|---|---|---|---|---|
| **Maxillary Component (Mean ± SD)** | | | | |
| SNA (degrees) | 83.13 ± 3.34$^{A}$ | 82.35 ± 4.13$^{A}$ | 81.14 ± 2.51$^{A}$ | 0.223 |
| Co-A (mm) | 86.66 ± 4.53$^{A}$ | 82.10 ± 4.86$^{B}$ | 81.68 ± 5.05$^{B}$ | 0.003* |
| PTVI-A (mm) | 49.98 ± 2.34$^{A}$ | 47.82 ± 4.17$^{A}$ | 47.91 ± 3.03$^{A}$ | 0.090 |
| **Mandibular Component (Mean ± SD)** | | | | |
| SNB (degrees) | 78.84 ± 2.77$^{A}$ | 78.82 ± 3.09$^{A}$ | 78.20 ± 2.01$^{A}$ | 0.702 |
| Co-Gn (mm) | 108.13 ± 4.50$^{A}$ | 104.86 ± 5.07$^{AB}$ | 102.72 ± 5.17$^{B}$ | 0.005* |
| P-NB (mm) | 2.25 ± 1.76$^{A}$ | 1.56 ± 1.28$^{A}$ | 1.94 ± 1.21$^{A}$ | 0.283 |
| PTVI-B (mm) | 47.70 ± 3.04$^{A}$ | 46.87 ± 5.47$^{A}$ | 47.41 ± 4.55$^{A}$ | 0.833 |
| **Maxillomandibular Relationship (Mean ± SD)** | | | | |
| ANB (degrees) | 4.28 ± 1.36$^{A}$ | 3.53 ± 3.08$^{A}$ | 2.94 ± 2.18$^{A}$ | 0.251 |
| NAP (degrees) | 6.29 ± 3.23$^{A}$ | 5.50 ± 7.12$^{A}$ | 4.06 ± 5.33$^{A}$ | 0.482 |
| **Vertical Component (Mean ± SD)** | | | | |
| FMA (degrees) | 28.17 ± 5.14$^{A}$ | 29.87 ± 4.43$^{A}$ | 27.00 ± 3.20$^{A}$ | 0.096 |
| SN.PP (degrees) | 6.07 ± 3.54$^{A}$ | 6.22 ± 3.98$^{A}$ | 7.29 ± 3.15$^{A}$ | 0.522 |
| SN.GoGn (degrees) | 29.64 ± 5.17$^{A}$ | 31.54 ± 4.05$^{A}$ | 29.89 ± 3.34$^{A}$ | 0.273 |
| SN.GoMe (degrees) | 33.06 ± 5.28$^{A}$ | 34.64 ± 4.13$^{A}$ | 32.85 ± 3.12$^{A}$ | 0.309 |
| NS.Gn (degrees) | 65.30 ± 3.00$^{A}$ | 66.26 ± 3.61$^{A}$ | 65.40 ± 2.23$^{A}$ | 0.516 |
| Occlusal plane (degrees) | 8.51 ± 3.79$^{A}$ | 9.77 ± 4.13$^{A}$ | 9.54 ± 3.07$^{A}$ | 0.535 |
| LAFH (mm) | 62.31 ± 3.78$^{A}$ | 61.81 ± 5.19$^{A}$ | 58.37 ± 3.30$^{B}$ | 0.011* |
| **Maxillary Dentoalveolar Component (Mean ± SD)** | | | | |
| SN.1 (degrees) | 103.04 ± 6.60$^{A}$ | 107.84 ± 5.90$^{B}$ | 104.66 ± 4.96$^{AB}$ | 0.028* |
| PTVI-1 (mm) | 55.96 ± 2.77$^{A}$ | 55.44 ± 4.95$^{A}$ | 54.71 ± 3.24$^{A}$ | 0.623 |
| PP-1 (mm) | 27.41 ± 2.29$^{A}$ | 26.87 ± 2.74$^{A}$ | 25.81 ± 2.01$^{A}$ | 0.127 |
| 1.NA (degrees) | 19.89 ± 5.81$^{A}$ | 25.48 ± 6.09$^{B}$ | 23.72 ± 5.50$^{AB}$ | 0.011* |
| 1-NA (mm) | 3.29 ± 2.03$^{A}$ | 4.94 ± 2.86$^{A}$ | 4.50 ± 2.31$^{A}$ | 0.101 |
| SN.4 (degrees) | 81.29 ± 4.07$^{A}$ | 82.76 ± 4.99$^{A}$ | 80.06 ± 4.09$^{A}$ | 0.145 |
| PTVI-4 (mm) | 38.04 ± 2.28$^{A}$ | 36.20 ± 3.74$^{AB}$ | 35.16 ± 3.20$^{B}$ | 0.028* |
| PP-4 (mm) | 19.28 ± 2.30$^{A}$ | 19.09 ± 2.42$^{A}$ | 18.31 ± 1.85$^{A}$ | 0.363 |
| SN.5 (degrees) | 79.33 ± 3.12$^{A}$ | 78.49 ± 5.46$^{A}$ | 77.99 ± 4.07$^{A}$ | 0.655 |
| PTVI-5 (mm) | 31.58 ± 2.42$^{A}$ | 29.80 ± 3.71$^{A}$ | 29.01 ± 3.32$^{A}$ | 0.056 |
| PP-5 (mm) | 18.81 ± 2.28$^{A}$ | 18.67 ± 2.42$^{A}$ | 17.60 ± 1.67$^{A}$ | 0.175 |
| SN.6 (degrees) | 66.70 ± 2.84$^{A}$ | 65.70 ± 4.65$^{A}$ | 66.98 ± 4.48$^{A}$ | 0.645 |
| PTVI-6 (mm) | 23.29 ± 2.37$^{A}$ | 21.68 ± 3.61$^{A}$ | 20.93 ± 3.59$^{A}$ | 0.092 |
| PP-6 (mm) | 17.10 ± 2.31$^{A}$ | 16.84 ± 2.27$^{A}$ | 15.72 ± 1.53$^{A}$ | 0.103 |
| SN.7 (degrees) | 52.96 ± 5.64$^{AB}$ | 50.92 ± 6.31$^{B}$ | 56.65 ± 5.02$^{A}$ | 0.007* |
| PTVI-7 (mm) | 13.29 ± 2.36$^{A}$ | 11.98 ± 3.02$^{A}$ | 11.71 ± 3.05$^{A}$ | 0.201 |
| PP-7 (mm) | 13.57 ± 2.36$^{A}$ | 11.37 ± 3.76$^{AB}$ | 10.29 ± 3.01$^{B}$ | 0.009* |
| **Mandibular Dentoalveolar Component (Mean ± SD)** | | | | |
| 1.NB (degrees) | 26.53 ± 4.64$^{A}$ | 25.64 ± 5.99$^{A}$ | 24.41 ± 4.50$^{A}$ | 0.463 |
| 1-NB (mm) | 3.94 ± 2.07$^{A}$ | 4.45 ± 2.20$^{A}$ | 3.37 ± 1.39$^{A}$ | 0.198 |
| PTVI- (mm) | 22.22 ± 3.78$^{A}$ | 20.99 ± 4.27$^{A}$ | 21.28 ± 4.05$^{A}$ | 0.611 |
| GoMe- (mm) | 28.18 ± 2.01$^{A}$ | 27.69 ± 2.62$^{A}$ | 26.63 ± 2.10$^{A}$ | 0.117 |
| **Soft Tissue (Mean ± SD)** | | | | |
| NLA (degrees) | 107.06 ± 11.07$^{AB}$ | 103.13 ± 10.35$^{A}$ | 114.09 ± 11.11$^{B}$ | 0.005* |
| E-Ls (mm) | 2.38 ± 2.19$^{A}$ | 2.05 ± 2.71$^{A}$ | 2.68 ± 2.07$^{A}$ | 0.683 |
| E-Li (mm) | 1.46 ± 3.05$^{A}$ | 0.06 ± 2.38$^{A}$ | 1.14 ± 1.88$^{A}$ | 0.151 |
| **Dental Relationships (Mean ± SD)** | | | | |
| Molar Relationship (mm) | 0.03 ± 1.17$^{A}$ | -0.42 ± 1.02$^{AB}$ | -0.93 ± 0.74$^{B}$ | 0.016* |
| Overjet (mm) | 4.43 ± 1.15$^{A}$ | 4.67 ± 1.55$^{A}$ | 4.48 ± 1.95$^{A}$ | 0.867 |
| Overbite (mm) | 5.00 ± 1.70$^{A}$ | 3.92 ± 1.48$^{A}$ | 4.04 ± 1.53$^{A}$ | 0.069 |

* Statistically significant difference for P < 0.05.
Different letters stand for statistically significant difference.

Table 5 - ANOVA and Tukey test results: means and standard deviation of cephalometric measurements means.(ANOVA – $T_3$-$T_1$)

| Variable | Group 1 (Pendulum) n = 18 | Group 2 (Jones Jig) n = 25 | Group 3 (Control) n = 19 | P |
|---|---|---|---|---|
| **Maxillary Component (Mean ± SD)** | | | | |
| SNA (degrees) | -1.07 ± 1.75$^{A}$ | 0.02 ± 1.85$^{A}$ | -0.67 ± 3.43$^{A}$ | 0.329 |
| Co-A (mm) | 1.22 ± 3.27$^{A}$ | 1.41 ± 3.59$^{A}$ | 3.20 ± 3.43$^{A}$ | 0.151 |
| PTVI-A (mm) | 0.73 ± 2.40$^{A}$ | 1.15 ± 2.29$^{A}$ | 1.08 ± 3.62$^{A}$ | 0.878 |
| **Mandibular Component (Mean ± SD)** | | | | |
| SNB (degrees) | -0.26 ± 1.73$^{A}$ | 0.74 ± 2.28$^{A}$ | -0.35 ± 2.24$^{A}$ | 0.169 |
| Co-Gn (mm) | 4.77 ± 5.82$^{A}$ | 5.98 ± 4.21$^{A}$ | 4.92 ± 3.31$^{A}$ | 0.626 |
| P-NB (mm) | 0.61 ± 0.98$^{A}$ | 0.46 ± 0.84$^{A}$ | 0.25 ± 0.81$^{A}$ | 0.473 |
| PTVI-B (mm) | 1.36 ± 3.62$^{A}$ | 2.03 ± 2.70$^{A}$ | 1.69 ± 5.09$^{A}$ | 0.851 |
| **Maxillomandibular Relationship (Mean ± SD)** | | | | |
| ANB (degrees) | -0.81 ± 2.02$^{A}$ | -0.72 ± 2.19$^{A}$ | -0.11 ± 3.03$^{A}$ | 0.796 |
| NAP (degrees) | -2.30 ± 4.68$^{A}$ | -2.00 ± 4.79$^{A}$ | -1.07 ± 6.81$^{A}$ | 0.771 |
| **Vertical Component (Mean ± SD)** | | | | |
| FMA (degrees) | 0.46 ± 2.55$^{A}$ | 1.72 ± 2.62$^{A}$ | 0.31 ± 4.48$^{A}$ | 0.298 |
| SN.PP (degrees) | 0.21 ± 1.83$^{A}$ | 0.24 ± 3.11$^{A}$ | 1.05 ± 3.22$^{A}$ | 0.578 |
| SN.GoGn (degrees) | 0.46 ± 2.29$^{A}$ | 0.23 ± 2.45$^{A}$ | 1.16 ± 5.47$^{A}$ | 0.689 |
| SN.GoMe (degrees) | 0.18 ± 2.14$^{A}$ | 0.40 ± 2.20$^{A}$ | 1.27 ± 4.89$^{A}$ | 0.552 |
| NS.Gn (degrees) | 0.93 ± 1.51$^{A}$ | 0.63 ± 2.14$^{A}$ | 1.40 ± 2.93$^{A}$ | 0.541 |
| Occlusal plane (degrees) | -0.05 ± 2.80$^{A}$ | 1.70 ± 3.32$^{A}$ | -1.22 ± 5.47$^{A}$ | 0.057 |
| LAFH (mm) | 3.63 ± 3.01$^{A}$ | 5.60 ± 2.82$^{A}$ | 3.48 ± 5.38$^{A}$ | 0.128 |
| **Maxillary Dentoalveolar Component (Mean ± SD)** | | | | |
| SN.1 (degrees) | 1.68 ± 7.01$^{A}$ | -1.63 ± 6.65$^{A}$ | -1.87 ± 4.32$^{A}$ | 0.147 |
| PTVI-1 (mm) | 1.40 ± 3.64$^{A}$ | 1.26 ± 3.12$^{A}$ | 1.63 ± 4.49$^{A}$ | 0.947 |
| PP-1 (mm) | 0.58 ± 1.78$^{A}$ | 1.68 ± 1.48$^{A}$ | 1.07 ± 3.12$^{A}$ | 0.273 |
| 1.NA (degrees) | 2.79 ± 6.63$^{A}$ | -1.63 ± 6.77$^{A}$ | -1.43 ± 4.74$^{A}$ | 0.051 |
| 1-NA (mm) | 0.98 ± 2.40$^{A}$ | 0.12 ± 2.55$^{A}$ | -0.18 ± 2.33$^{A}$ | 0.322 |
| SN.4 (degrees) | -0.29 ± 5.47$^{A}$ | -1.83 ± 4.69$^{A}$ | 0.59 ± 3.23$^{A}$ | 0.210 |
| PTVI-4 (mm) | 1.24 ± 2.87$^{A}$ | 2.20 ± 2.09$^{A}$ | 2.10 ± 4.49$^{A}$ | 0.587 |
| PP-4 (mm) | 1.80 ± 1.41$^{A}$ | 2.13 ± 1.24$^{A}$ | 1.63 ± 2.81$^{A}$ | 0.673 |
| SN.5 (degrees) | -1.43 ± 6.11$^{A}$ | 1.76 ± 4.61$^{A}$ | 0.06 ± 3.05$^{A}$ | 0.095 |
| PTVI-5 (mm) | 1.20 ± 2.83$^{A}$ | 2.22 ± 2.00$^{A}$ | 1.81 ± 4.56$^{A}$ | 0.587 |
| PP-5 (mm) | 1.86 ± 1.48$^{A}$ | 2.10 ± 1.33$^{A}$ | 1.95 ± 2.75$^{A}$ | 0.915 |
| SN.6 (degrees) | -0.77 ± 6.67$^{A}$ | 1.55 ± 4.85$^{A}$ | 0.20 ± 5.65$^{A}$ | 0.409 |
| PTVI-6 (mm) | 0.61 ± 2.68$^{A}$ | 1.82 ± 1.89$^{A}$ | 1.98 ± 4.60$^{A}$ | 0.356 |
| PP-6 (mm) | 2.10 ± 1.57$^{A}$ | 2.39 ± 1.54$^{A}$ | 2.36 ± 3.06$^{A}$ | 0.896 |
| SN.7 (degrees) | 1.59 ± 6.53$^{AB}$ | 5.44 ± 7.31$^{A}$ | -0.76 ± 5.81$^{B}$ | 0.010* |
| PTVI-7 (mm) | 0.75 ± 2.73$^{A}$ | 1.42 ± 1.91$^{A}$ | 1.47 ± 4.00$^{A}$ | 0.695 |
| PP-7 (mm) | 2.37 ± 2.16$^{A}$ | 4.40 ± 2.89$^{A}$ | 4.32 ± 3.90$^{A}$ | 0.074 |
| **Mandibular Dentoalveolar Component (Mean ± SD)** | | | | |
| 1.NB (degrees) | 6.18 ± 6.72$^{A}$ | 2.52 ± 5.56$^{AB}$ | -0.73 ± 3.28$^{B}$ | 0.001* |
| 1-NB (mm) | 1.70 ± 1.64$^{A}$ | 1.41 ± 1.89$^{A}$ | 0.06 ± 0.85$^{B}$ | 0.004* |
| PTVI- (mm) | 2.27 ± 2.68$^{A}$ | 2.83 ± 2.23$^{A}$ | 2.42 ± 3.14$^{A}$ | 0.774 |
| GoMe- (mm) | 2.04 ± 1.60$^{A}$ | 3.76 ± 2.37$^{B}$ | 1.90 ± 1.85$^{A}$ | 0.004* |
| **Soft Tissue (Mean ± SD)** | | | | |
| NLA (degrees) | 2.06 ± 9.01$^{A}$ | 1.60 ± 7.54$^{A}$ | 2.36 ± 8.51$^{A}$ | 0.975 |
| E-Ls (mm) | 1.56 ± 1.01$^{A}$ | 1.91 ± 1.53$^{A}$ | 1.03 ± 2.03$^{A}$ | 0.199 |
| E-Li (mm) | 0.28 ± 1.24$^{A}$ | 0.74 ± 1.21$^{A}$ | 1.40 ± 2.63$^{A}$ | 0.165 |
| **Dental Relationships (Mean ± SD)** | | | | |
| Molar relationship (mm) | -2.62 ± 1.29$^{A}$ | -2.36 ± 1.36$^{A}$ | -0.22 ± 1.24$^{B}$ | 0.000* |
| Overjet (mm) | -1.35 ± 1.37$^{AB}$ | -1.90 ± 1.69$^{A}$ | -0.14 ± 2.00$^{B}$ | 0.005* |
| Overbite (mm) | -2.47 ± 1.68$^{A}$ | -1.56 ± 1.51$^{A}$ | -0.13 ± 1.94$^{B}$ | 0.000* |

* Statistically significant difference for P < 0.05
Different letters stand for statistically significant difference.

significantly different, representing a trend of an older age in group 1. However, most studies in the literature consider compatibility of initial age and treatment time,[2,5] only, which is considered as sufficient to characterize a reliable sample compatibility.[7]

Changes during treatment for the variables of both maxillary and mandibular components were similar among the three groups (Table 5), and improvements in the maxillomandibular relationship were observed. However, this change was more significant in the experimental groups and it is justified by the treatment performed. Conversely, although this improvement was less significant in the control group, it was due to craniofacial growth. The results prove that intraoral distalization appliances do not interfere in craniofacial growth and development.[6,19,21]

Assessment of the vertical skeletal variables in the initial stage, except for the lower anterior face height (LAFH), demonstrates that the measurements showed no statistically significant difference among groups. Changes happening as a result of treatment and growth were statistically similar for the three groups; however, they were numerically higher in the Jones jig group. The different changes for the Jones jig and control groups occurred due to the extrusion of first and second premolars during treatment, in other words, although not significant, extrusion of these teeth was slightly higher in the Jones jig group than in the control group (Table 5).

Results demonstrate that the three groups showed clockwise mandibular rotation, which confirms the downward displacement of the mandible, as observed during the post-distalization stage of several studies.[3,6,7,8,10,21] Assuming that this change occurred as a result of maxillary premolars and molars extrusion due to loss of anchorage and the distalization effect, it is thought that during corrective treatment, correction of extrusions will occur and the rotation will be reversed as a consequence. However, according to Taner-Sarisoy and Darendeliler,[23] most orthodontic mechanics, if not all, are extrusive and this extrusion increases the LAFH during treatment, keeping it increased during the retention period. Moreover, an increase in LAFH due to craniofacial growth and development is common.[18] Therefore, it can be stated that mandibular rotation is related to changes in the distalization phase,[3,8,21] the corrective orthodontic mechanics[23] and craniofacial growth and development.[18]

During the observation period, changes in the nasolabial angle were similar in the three groups. This finding demonstrates that the treatment protocol used does not interfere in the tegumental profile; therefore, the facial characteristics are maintained in the experimental groups.[8]

When assessing the maxillary dentoalveolar component, it was observed that only the maxillary second molars showed significant changes, i.e., at treatment onset, the Jones jig group presented the second molars more distally angulated than the control group, and during treatment, this group also showed a greater mesial angulation in relation to the control group. This initial position can be explained by the difference in the mean initial age that, although not significant, was lower in the Jones jig than in the control group (Table 1); hence, the second molars were more below the occlusal plane, showing a more distal position.

Regarding the positioning of the mandibular incisors, a minor change was observed in the control group, while the Pendulum and Jones jig groups presented greater buccal tipping and protrusion of the mandibular incisors**,** certainly related to the use of Class II rubber bands and overjet correction, which occurred as a consequence of the compensation of the mandibular teeth (Fig 2).

As for the vertical positioning of the mandibular molars, significant extrusion was greater in the Jones jig group than in the Pendulum and control groups. This change was related not only to the use of Class II rubber bands, but also to the end of eruption, since, at the beginning of treatment, the mandibular molars were more below the occlusal plan in comparison to the Pendulum group because patients were slightly younger and had greater potential for eruption.[13]

The molar relationship at treatment onset showed a statistically significant difference between the Pendulum and control groups, confirming the trend of greater severity of the Pendulum group. As expected, during observation of the change in molar relationship in the course of treatment, the experimental groups presented significative Class II correction when compared to the control group in which malocclusion remained. Therefore, it appears that the treatment successfully decreased anteroposterior interarch discrepancy, which reveals the contribution of this therapy in the correction of the Class II molar relationship and accentuated overjet.

The literature[3,7,8] proves that intraoral distalization appliances followed by fixed corrective orthodontics are effective in the correction of Class II and that there is stability of about 82% of the occlusal results achieved in the long-term.[1]

Overjet and overbite were similar in the three groups at treatment onset; however, there was a correction in the treated groups during treatment, which was not observed in the control group. This difference was expected since patients in the experimental groups were subjected to corrective treatment and individuals in the control group, in which malocclusion remained at the end of the observation period, the overjet and overbite also remained, i.e., the Class II malocclusion does not correct itself.

Despite the distinct insertion sites among the appliances assessed, i.e., palatal and buccal, no changes were related to this difference, since orthodontic treatment with fixed appliance acts with the purpose of neutralizing the specific effects of intraoral distalization and finalizing the corrective treatment.

## CONCLUSIONS

Intraoral distalization appliances followed by fixed corrective orthodontics do not interfere in the cephalometric pattern and tegumental profile, as demonstrated by the results which are similar to the control group with regard to the components of both the maxilla and the mandible, maxillomandibular relationship, craniofacial and tegumental pattern. The mandibular incisors showed significant protrusion and buccal tipping in the experimental groups and the maxillary second molars showed more mesial angulation in the Jones jig group. Finally, correction of Class II malocclusion, overjet and overbite were observed in the Pendulum and Jones jig groups, and in the control group, the initial malocclusion remained at the end of the observation period.

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