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# Comparison of the Condyle Sagittal Position of Class I and Class II Division 2 in Orthodontic Patients

Murilo Fernando Neuppmann Feres<sup>1</sup>, Osama Eissa<sup>2</sup>, Marina Guimarães Roscoe<sup>3</sup>, Tarek El-Bialy<sup>4</sup>

## ABSTRACT

**Aim:** To compare the condyle sagittal position of class I and class II division 2 in orthodontic patients.

**Materials and methods:** Fifty orthodontic cases (30 females and 20 males; 12–31 years) from the records of an Orthodontic Graduate Program were collected. Such cases presented cone-beam computed tomography (CBCT) as part of their initial diagnostic examinations. The study sample constituted two groups, *i.e.* class I and class II division 2 groups. A previously calibrated examiner performed the measurements of the images, representing the distance between the condyle and the articular surface of the glenoid fossa, both anteriorly (anterior disk space—ADS) and posteriorly (posterior disk space—PDS). Descriptive statistics were performed. Data were normally distributed, and parametric tests were used. Paired sample test was used to identify differences between the right and the left joints. Differences between class I and class II/2 groups were tested using independent *t* test. All statistical tests were interpreted at 5% significance level.

**Results:** When the study groups were compared in relation to the dimensions observed for the right and the left ADS and PDS, no significant differences were detected. This study also calculated the differences between right and left disk spaces within the groups, and the differences were not significant for both class I and class II/2 groups.

**Conclusion:** The results demonstrated, after the performance of a CBCT comparative analysis, that there is no significant difference between class II/2 and class I orthodontic patients in relation to the condyle sagittal position.

**Clinical significance:** The results collected here refute the expectation of spontaneous mandibular anterior repositioning after correcting the overbite in class II/2 patients.

**Keywords:** Cone-beam computed tomography, Condylar position, Malocclusion.

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## INTRODUCTION

The class II division 2 (class II/2) malocclusion was originally characterized by Angle as having distal occlusion of the lower teeth, in addition to specific features such as “slight narrowing of the maxillary arch and bunching of the maxillary incisors, with overlapping and lingual inclination.”<sup>1</sup> Although practitioners intuitively recognize such peculiar occlusal characteristics, there appears to be no full consensus on the exact sagittal skeletal features of this malocclusion.<sup>2,3</sup> Still, the typical class II/2 vertical skeletal deficiency<sup>2,4,5</sup> has been documented to establish early and to become more pronounced with age.<sup>6</sup>

Historically, there has been a belief according to which class II/2 patients present their mandible posteriorly entrapped in the glenoid fossa.<sup>7,8</sup> Such assumption has been reinforced by clinical subjective (yet plausible) observation that retroclined upper incisors might potentially represent relevant occlusal interferences in class II/2 patients with no overjet.<sup>9</sup> If scientifically ascertained, the elimination of potential interferences could theoretically enable class II correction by spontaneous forward repositioning of the mandible.<sup>10,11</sup>

Therefore, researches are still necessary in order to clarify if class II/2 patients do present posteriorly displaced condyles, especially considering that both class II malocclusions<sup>12,13</sup> and deep overbites<sup>13–16</sup> have already been associated with TMJ disorders.

In this sense, several studies have already been investigated condyle sagittal position of class II orthodontic patients.<sup>17–24</sup> However, part of these articles reported comparative analyzes including class II division 1 and division 2 patients, with no differentiation between these groups.<sup>20–23</sup> As for the research that

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specifically compared class II/2 patients with other malocclusion groups, results concerning the condyle anteroposterior position might be considered controversial if not derived from the application of questionable scientific methods.<sup>17–19,24</sup>

Therefore, the objective of this study was to test the null hypothesis that there is no significant difference in condyle sagittal position among class I and class II/2 orthodontic patients using cone-beam computed tomography (CBCT).

## MATERIALS AND METHODS

This is a cross-sectional analytical observational study. Sample size was calculated to detect a clinically significant difference of 1.5 mm

for the parameter “posterior disk space” (PDS). An  $\alpha$  error of 0.05 was set to achieve a test power of 80%. The sample size calculation demonstrated that 25 patients were required in each group.

## Patients

Cone-beam computed tomography scans from 50 orthodontic cases, which had the examination as part of their initial diagnostic examinations, were consecutively collected from the Orthodontic Graduate Program records at the University of Alberta. Cone-beam computed tomography images were acquired for orthodontic purposes, where conventional cephalometric and panoramic radiographs did not provide sufficient information for proper diagnosis and/or treatment planning, *e.g.*, impacted teeth, airway measurement, and anchorage temporary devices insertion.

## Inclusion and Exclusion Criteria

Data from patients with clinically evident TMJ disorders were not included in the study. In addition, records were excluded if the patient had reported any pain or discomfort in TMJ, as depicted in their clinical records. Neither clicking, crepitation, and limitation of mouth opening, nor mandibular dysfunctions were ever present during the orthodontic treatment admission. Additionally, all patients presented no crossbites, class II subdivisions, asymmetrical facial appearance, nor had positive history of orthodontic treatment, surgery, trauma, or other degenerative joint disease.

## Groups

The study sample constituted two groups. Class I group included records from 25 patients with ANB angle values ranging from  $0^\circ$  to  $4^\circ$ <sup>25</sup> and bilateral class I molar relationship. Class II division 2 group included records from 25 patients with ANB angle values from  $5^\circ$  onward.<sup>25</sup> Furthermore, group II/2 individuals necessarily presented bilateral class II molar relationship, retroclined upper central incisors, and deep overbite (more than 50%).

Group I included CBCT examinations from 14 female and 11 male patients. These patients had a mean age of 19.0 years ( $\pm 6.1$ ). Group II was composed of 16 female and 9 male orthodontic patients, with a mean age of 21.6 years ( $\pm 7.6$ ).

## Cone-beam Computed Tomography

The images were acquired by i-CAT CBCT scan (Imaging Sciences International, Hatfield, PA, USA). The CBCT machine was routinely calibrated, and participants were provided with lead apron. Cone-beam computed tomography protocol used in this study was a large field of view (16 cm width  $\times$  13 cm height), 120 kVp, 24 mAs, 20 seconds, scan time, 0.3 mm voxel size, and 303 basis projections. Cone-beam computed tomography images were taken with the patients in a sitting upright position with their back as perpendicular to the floor as possible. Their head was stabilized with ear rods inserted in the external auditory meatus.

## 3D Measurements

The same examiner, who had been previously calibrated, performed the image measurements. Slices (0.5 mm) from the sagittal sections were evaluated with the anteroposterior diameter of the right and left condyle was the greatest in order to represent the exact distance between the condyle and the articular surface of the glenoid fossa, both anteriorly and posteriorly.

Linear measurements of disk space between condyle and the articular fossa were performed according to Ikeda and Kawamura.<sup>26</sup> From reconstructed sagittal sections, a horizontal line was drawn

parallel to Frankfort horizontal plane and tangent to the uppermost area of the glenoid fossa (A). Two other lines originating from (A) were traced tangential to the most anterior (B) and to the most posterior surface (C) of the condyle. A perpendicular distance between B and D, C, and E were then measured and considered as anterior disk space (ADS) and PDS distances, respectively (Figs 1 and 2).

Measurements from 16 randomly selected patients, 8 from each group, were repeated after a 2-week interval by the same examiner and compared to calculate the measurement errors.

## Data Analyses

Statistical analysis was performed with SPSS Version 21.0 (SPSS Incorporated, Chicago, IL, USA). Kolmogorov–Smirnov test showed that the data were normally distributed ( $p$  value  $> 0.05$ ), and thus, parametric tests were used. Descriptive statistics were performed and reported with means and standard deviations for all variables in both groups. A paired sample test was used to identify the significance of differences in disk spaces dimensions of the right and the left joints for the same patient. Differences between the ADS and the PDS in class I and class II/2 groups were tested using independent  $t$  test. All statistical tests were interpreted at the 5% significance level.

## RESULTS

Reliability for CBCT measurements was found to be satisfactory,<sup>27</sup> as intraclass correlation coefficients ranged from 0.85 to 0.98. There were no significant differences regarding mean age ( $p$  value  $> 0.05$ ) or gender distributions ( $p$  value  $> 0.05$ ).

Mean ADS for Group I was 2.044 mm ( $\pm 0.7066$  mm) and 2.048 mm ( $\pm 0.7741$  mm) for right and left sides, respectively. Group II presented similar measurements for right ( $2.100 \pm 0.7211$  mm) and left ( $2.188 \pm 1.0191$  mm) ADS. When the study groups were compared in relation to the dimensions observed for the right ( $p = 0.783$ ) and left ADS ( $p = 0.587$ ), no significant differences were detected.

As for PDS right and left measurements, group I presented 2.180 mm ( $\pm 0.6096$  mm) and 2.260 mm ( $\pm 0.8391$  mm), respectively. These values were not significantly different from the ones obtained for group II (right:  $p$  value = 0.771; left:  $p$  value = 0.825), which presented

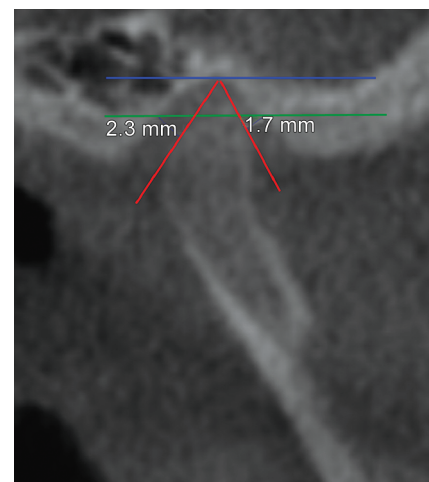


Fig. 1: Measurement of ADS and PDS in a class I individual

2.120 mm ( $\pm 0.8211$  mm) and 2.208 mm ( $\pm 0.8134$  mm) for right and left sides, respectively.

This study also calculated the differences between right and left disk spaces within the groups (Table 1), and the differences were not significant for both class I (ADS:  $p$  value = 0.973; PDS:  $p$  value = 0.522) and class II/2 (ADS:  $p$  value = 0.625; PDS:  $p$  value = 0.534) groups.

This study has thus verified that there is no significant difference in condyle sagittal position among class I and class II/2 orthodontic patients nor side positional discrepancies, within each one of the groups studied here.

## DISCUSSION

Numerous studies have been performed in order to describe the TMJ as correlated with different malocclusions and skeletal patterns. For instance, studies enrolling class III patients reported wider<sup>19,24</sup> and shallower fossae,<sup>19,28</sup> larger articular eminence inclinations,<sup>23</sup> more anteriorly inclined condylar heads,<sup>19</sup> and anteriorly displaced condyles.<sup>18,24,29,30</sup> Hyperdivergent individuals may present more superiorly positioned condyles,<sup>31</sup> while patients with asymmetric malocclusions, such as in the case of class II or III subdivisions, may as well present asymmetric condylar morphology and/or positions.<sup>32,33</sup>

It has also been hypothesized by Monje and collaborators<sup>34</sup> that the counterclockwise rotation of the mandible—as presented in class II/2 patients—may affect both condyle morphology and

position. However, the results derived from this study revealed no specific features in relation to the condyle sagittal position of class II/2 orthodontic patients. This finding is in accordance with the study of Pullinger and coworkers<sup>17</sup> that compared class II/2 with class I individuals. As described by these researches, class II/2 individuals seem to present virtually concentric condyle positions as do class I patients.<sup>18</sup> This has also been confirmed by our study that revealed similar values for ADS and PDS within both the groups (class I and class II/2) investigated here. Furthermore, this study did not find any positional dissimilarity between right and left sides for neither group. This finding was somehow expected, since the patients enrolled in this study did not present unilateral posterior crossbites or class II subdivisions; and both clinical scenarios are expected to produce asymmetrical condyle positions.<sup>32,33,35</sup>

However, studies with similar comparative groups observed distinct findings when compared to ours.<sup>17,24</sup> Pullinger and coworkers<sup>17</sup> presented higher frequencies of posteriorly positioned condyle among class II/2 individuals, although the study sample size was considered to be excessively small for meaningful conclusions. In addition, Song and collaborators,<sup>24</sup> while evaluating joint spaces in similar groups, found that class II/2, when compared to class I patients, present larger posterior joint spaces and smaller anterior joint spaces. This finding is actually opposed to the original theory, according to which class II/2 patients present posteriorly displaced condyles.<sup>7,8</sup> Considering our results and the referred literature,<sup>17–19,24</sup> it is the authors' opinion that the sagittal position of the condyle may not be considered as a reliable predictor for vertical or horizontal facial morphology, as previously observed by Burke and collaborators.<sup>36</sup>

Therefore, the current knowledge seems to also refute the expectation of spontaneous mandibular anterior repositioning after correcting the overbite in class II/2 patients. As depicted in an earlier experimental study performed by Coskuner and Ciger,<sup>37</sup> even after class II/2 patients had been subjected to maxillary expansion (Quad-helix appliance) and incisors protrusion/ intrusion (utility arches), no significant changes were observed for neither anterior nor posterior joint spaces. In this sense, spontaneous mandibular correction remains unconfirmed as assumed before.<sup>38,39</sup>

Cone-beam computed tomography is currently the most widely used imaging examination method for TMJ and has been extensively indicated as a useful option for evaluating this anatomic area.<sup>40</sup> However, this study presents limitations, such as the inclusion of patients of a wide age range (12 to 31 years), although both groups presented no significant differences concerning age.

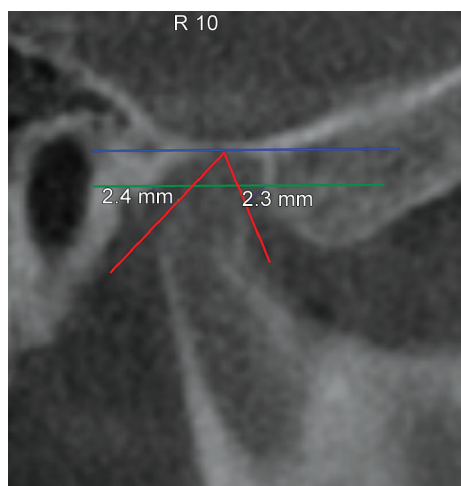


Fig. 2: Measurement of ADS and PDS in a class II/2 individual

Table 1: Description of the anterior and posterior disk spaces measurements (mm) for right and left sides, and mean differences between groups and sides (within groups)

Measurement		Group						
		I			II/2			$\Delta$ Groups
		Mean	SD	Range	Mean	SD <sup>†</sup>	Range	Mean/SD
ADS	Right	2.044	0.7066	1.2–3.8	2.100	0.7211	1.0–4.6	–0.056/ (0.202)
	Left	2.048	0.7741	1.2–4.4	2.188	1.0191	0.8–5.6	–0.140/ (0.256)
PDS	$\Delta$ RL	–0.004	0.581	–	–0.088	0.890	–	–
	Right	2.180	0.6096	1.3–3.7	2.120	0.8211	0.8–4.2	0.060/(0.205)
	Left	2.260	0.8391	0.7–3.8	2.208	0.8134	1.1–4.4	0.052/(0.234)
	$\Delta$ RL	–0.080	0.616	–	–0.088	0.698	–	–

SD<sup>†</sup>: standard-deviation;  $\Delta$ Groups: difference between groups (mean/SD);  $\Delta$ RL: difference between sides (mean/SD)



There were no comparative analyzes including class II division 1 or class III individuals. Instead, this study preferred to focus on providing information regarding the hypothetical malposition of class II/2 patients' condyle. Also, records were collected from a single center, which might not truly mimic what is expected to represent the class II/2 population.

Still, it is necessary to emphasize that the sample was consecutively recruited, which might diminish potential selection biases. Although sample size was considered to be adequate, future studies should include a broader range of malocclusions and evaluation measurements.

## CONCLUSION

The results from this study demonstrated, after the performance of a CBCT comparative analysis, that there is no significant difference between class II/2 and class I orthodontic patients in relation to the condyle sagittal position.

## CLINICAL SIGNIFICANCE

The results collected here refute the expectation of spontaneous mandibular anterior repositioning after correcting the overbite in class II/2 patients.

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This study was approved by the Human Research Ethics Board at the University of Alberta, Edmonton, Alberta, Canada (Protocol # 000000000000).

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