## Original Article
# Skelate changes induced by orthodontic in class II division 1 by CBCT: a long-term follow-up prospective study

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Abstract: Objective: To identify and evaluate changes in the sagittal position of point B due to orthodontic treatment using CBCT. Materials and methods: The subjects comprised 80 patients received fixed appliance. In this population, group 1 consisting of 40 patients with Class II division 2 malocclusion and group 2 consisting of 40 patients with minor crowding in the beginning of the treatment and required no or minimal maxillary anterior tooth movement. Treatment changes in incisor inclination, sagittal position of point B, SNB and movement of incisor root apex and incisal edge were calculated on pretreatment and post treatment on CBCT. Results: Assessment of local changes in point B revealed that the point had moved backward. No significant change was observed in the value of the sella-nasion-point B angle (SNB) in both the study and control groups. However, the changes of horizontal displacement after treatment in SNB between the two groups were found to be significant. There were no significant changes in the vertical and Z position of points B in both group. Conclusions: The position of point B was affected by local bone remodeling during orthodontic treatment. These changes significantly affect the SNB angle.

Keywords: Class II division 2, point B, incisor proclination

## Introduction

Point B are commonly used to determine the sagittal denture base relationship [1]. However, Some authors have stated that point B was influenced by the inclination of the anterior cranial base [2-4], patient age, position of the nasion [5, 6], and the degree of facial prognathism [7]. Unless all of these factors are accounted for, the validity of studies using points B as stable skeletal reference points may be questionable, and this may affect the accuracy of the results [8].

Few studies have attempted to investigate the effect of incisal tooth movements on the position of points B in previous literatures [9-15]. Only one study [16] assessed the changes of SNA and SNB by orthodontic treatment. During examination of pre-treatment and post-treatment cephalometric data on Class II division 2 malocclusion, Cleall and BeGole[16] noted that the SNB angle was slightly increased.

Cephalometric studies are subject to error, and reports often indicate small changes caused by treatment. Many studies have attempted to assess the accuracy of cephalometric measurements as applied three-dimensionally because of known intrinsic limitations of these images, such as distortion and magnification. In some cases, the magnitude of error may approach the therapeutic changes and raise doubt about their validity [17-19]. This is a common fault of cephalometric studies.

Therefore, the aim of this study was to isolate and evaluate changes in the position of points B purely due to incisal inclination changes because of orthodontic treatment.

## Material and methods

Ethical approval was obtained for this study from the Ethics Committee of the stomatology hospital of the Wenzhou Medical University. The participants were informed about the treatment

**Table 1.** CBCT distance, and angular definition

| Angles, distance | Definition |
| --- | --- |
| SNB | angle formed by the intersection of the nasion-sella and nasion-point B lines |
| Three-dimensional position of the root | perpendicular distance from the maxillary incisor root apex to the reference plane |
| Three-dimensional position of the crown | perpendicular distance from the maxillary incisor root apex to the reference plane |
| Three-dimensional position of the point B | perpendicular distance from the incisal edge of the mandibular incisor to the reference plane |
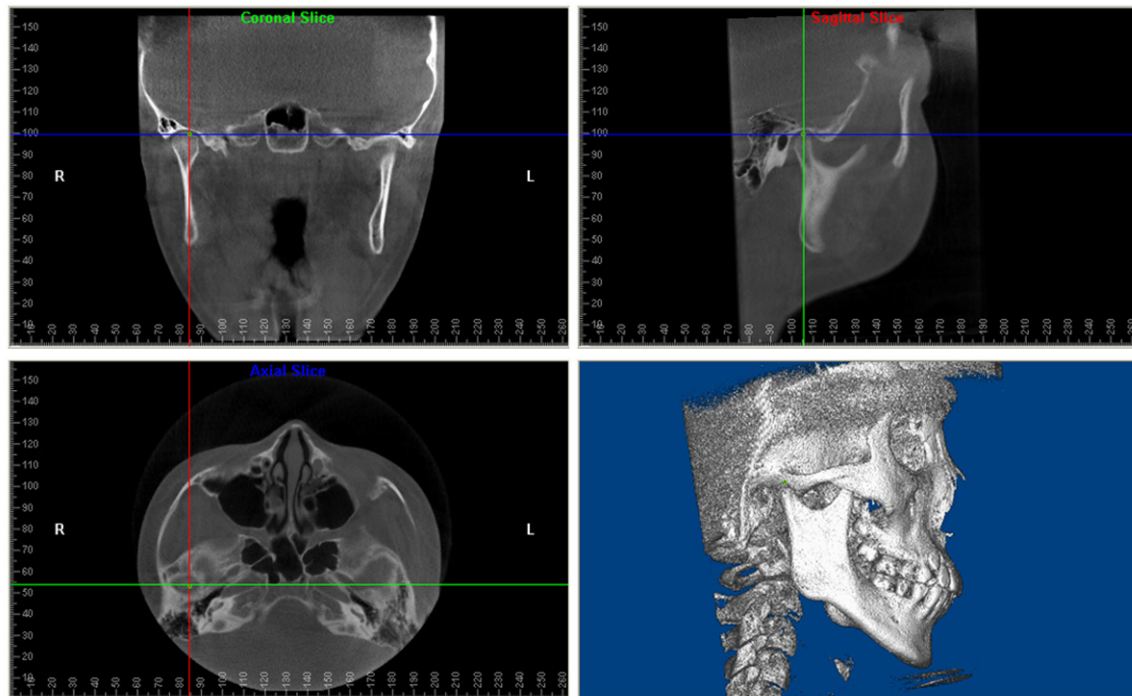


**Figure 1.** Example of the views seen using the Dolphin Imaging program.

procedures and assured of the confidentiality of the collected information. Only those who were given written consent were included in the research.

*Subjects*

The inclusion criteria for this study has been described in previous article [20], the patient sample, appliances, and clinical techniques used in this study were all identical to that described in the earlier article.

*CBCT analysis*

All radiographs used in the present study were taken with the same CBCT machine (New Tom VGi, Italy). Digital imaging and communications in medicine data sets were then imported into Dolphin Imaging 10.1 (Version 11.0, Dolphin Imaging & Management Solutions, Chatsworth, Calif) in order to identify anatomic landmarks using the 3D data. A line connecting sella and nasion corrected the pitch (x-axis), a line parallel to the inferior surface of the sphenoid bone at the antero-posterior position of nasion corrected roll (z-axis), and a line parallel to the anterior border of nasion corrected the yaw (y-axis). The x, y, and z coordinates of incisal edge, incisor root apex, and Point B were defined by using the Dolphin 3D program in the sagittal, axial, and coronal views. The twenty-one parameters were used in this study, see

**Table 2.** Treatment changes in study and control groups

| Measurement | Class II Division 2 Group | | | P | Sig | Control Group | | | P | Sig |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | T1 | T2 | T2-T1 | | | T1 | T2 | T2-T1 | | |
| | Mean + SD | Mean + SD | Mean + SD | | | Mean + SD | Mean + SD | Mean + SD | | |
| SNB, degree | 75.12+3.56 | 74.02+3.78 | -0.9+1.23 | 0.528 | NS | 79.36+4.12 | 79.02+4.32 | -0.26+0.56 | 0.65 | NS |
| N-L1Ap (x), mm | -2.45+1.52 | -3.70+1.23 | -1.25+1.46 | 0.001 | *** | -2.12+1.18 | -1.97+1.23 | 0.15+0.48 | 0.283 | NS |
| N-L1Ap (y), mm | 101.13+8.33 | 100.91+9.32 | -0.22+0.13 | 0.795 | NS | 100.12+8.20 | 100.32+8.22 | 0.20+0.22 | 0.382 | NS |
| N-L1Ap (z), mm | 1.21+1.26 | 1.35+0.24 | 0.14+0.20 | 0.234 | NS | 1.27+1.18 | 1.40+0.23 | 0.13+0.52 | 0.352 | NS |
| N-L1Ed (x), mm | -5.60+2.23 | -10.43+2.65 | 4.83+2.43 | 0.001 | *** | -3.28+1.46 | 3.68+1.53 | 0.4+1.12 | 0.438 | NS |
| N-L1Ed (y), mm | -91.35+9.55 | -90.68+9.32 | -1.33+2.43 | 0.931 | NS | -90.32+7.72 | -90.55+7.78 | -0.23+0.38 | 0.624 | NS |
| N-L1Ed (z), mm | 8.14+3.27 | 7.25+1.38 | -1.11+1.15 | 0.432 | NS | 8.41+2.56 | 7.35+2.21 | -1.06+0.52 | 0.463 | NS |
| N-B (x), mm | -3..26+1.23 | -4.68+1.45 | -1.42+1.33 | 0.001 | *** | -2.23+1.36 | -2.25+1.34 | -0.02+0.57 | 0.78 | NS |
| N-B (y), mm | 70.28+5.16 | 70.82+5.45 | 0.54+0.32 | 0.512 | NS | 70.17+6.22 | 70.33+5.28 | 0.16+0.12 | 0.912 | NS |
| N-B (z), mm | 1.23+1.32 | 1.43+0.45 | 0.30+0.42 | 0.512 | NS | 1.44+41.35 | 1.60+1.32 | 0.16+0.42 | 0.257 | NS |

***$P<0.001$; NS indicates not significant.

**Table 1**. The Dolphin Imaging 3D module allowed placement of landmarks using any one of the four available views (volumetric, sagittal, transverse, and vertical; **Figure 1**).

Measures were traced by the same operator by hand, and all measurements were carried out with a gauge to the nearest 0.1 mm. CBCT landmarks used in this study are identified in **Figure 1**.

*Statistical analysis*

Data analysis was performed by SPSS for Windows, version 14.0 (SPSS Inc, Chicago, Ill). The differences for the age, gender, and treatment time were measured using chi-square test. Means and standard deviation between the pre-treatment and post-treatment measurements were studied using Wilcoxon paired t-test. Differences between groups were analyzed by Mann-Whitney U-test. The level of significance was set at $P<0.05$.

To calculate systematic and random errors, 10 subjects were randomized retraced, and landmarks were retraced 2 months after the first measurement, and all measurements were repeated to estimate the repeatability of the measurements. Systematic error was not statistically significant. The random measurement error was calculated according to Dahlberg mention method. For linear and angular measurements, the error varied between 0.22 mm and 1.01 degrees; 0.16 mm and 0.38 degrees, respectively. It revealed that there was no any random measurement error.

**Results**

Systematic error was not statistically significant. For linear and angular measurements, t there was also no any random measurement error.

Incisal edges of mandibular incisors in the study group were moved backward 4.83 mm, the difference was statistically significant, **Table 2**. Statistically nonsignificant similar movement were observed in the control group, **Table 2**. The difference for the movement of the incisal edge between the two groups was statistically significant, **Table 3**.

The apex of incisors in the study group was moved backward 1.25 mm in the mandibular. The movement in the study group was statistically significant, while it was no significant in the control group, **Table 2**. The difference between the two groups was also statistically significant, **Table 3**. The vertical and Z displacement was not statistically significant in both groups, the difference between the two groups was also not statistically significant, **Table 3**.

The change in SNB degree between T1 and T2 measurements for both groups was no statistically significant. However, the changes of SNB between the two groups were found to be significant, see **Tables 2** and **3**.

The result revealed that incisal inclination changes result in the position of points B significant backward. However, the local vertical and Z displacement was not statistically significant in both groups, **Table 3**.

**Table 3.** Comparison of treatment changes between study and control groups for angular and linear measurements

| Measurement | Class II Division 2 Group | | Control Group | | P | Sig |
| | T2-T1 | | T2-T1 | | | |
| | Mean | SD | Mean | SD | | |
|---|---|---|---|---|---|---|
| SNB, degree | -0.9 | 1.23 | 0.26 | 0.56 | 0.000 | *** |
| N-L1Ap (x), mm | -1.25 | 1.46 | 0.15 | 0.48 | 0.001 | *** |
| N-L1Ap (y), mm | -0.22 | 0.13 | 0.20 | 0.22 | 0.632 | NS |
| N-L1Ap (z), mm | 0.14 | 0.20 | 0.13 | 0.52 | 0.423 | NS |
| N-L1Ed (x), mm | 4.83 | 2.43 | 0.40 | 1.12 | 0.001 | *** |
| N-L1Ed (y), mm | -1.33 | 2.43 | -0.23 | 0.38 | 0.001 | *** |
| N-L1Ed (z), mm | -1.11 | 1.15 | 1.06 | 0.32 | 0.52 | NS |
| N-B (x), mm | -1.42 | 1.33 | -0.02 | 0.57 | 0.001 | *** |
| N-B (y), mm | 0.54 | 0.32 | 0.16 | 0.12 | 0.314 | NS |
| N-B (z), mm | 0.30 | 0.42 | 0.16 | 0.42 | 0.423 | NS |

***$P<0.001$; NS indicates not significant.

## Discussion

The aim of this study was to investigate whether the position of point B are affected by local bone remodeling using CBCT in Class II division 2 malocclusion.

Most of the previous studies have been limited by the fact that traditional 2D static imaging techniques could not truly show the 3D anatomy. Currently, most of authors had come to a conclusion that CBCT images could provide a more accurate analysis of treatment results [21-24]. Although the relationship between the position of Point B and incisor inclination was found to be interrelated in previous studies [11, 12], limitations of traditional images, such as distortion and magnification, could be interpreted as the weakness of the previous studies results.

Besides imaging techniques, the wide range of ages of samples and the lack of a control group in order to account for the effect of growth on the position of point B could also be considered as the most important limitation in previous studies evaluating the effect of incisor inclination on the point B position. In the previous studies, the sample of subjects was not consistent which range from teenager to adults. It is clear that skeletal response to tooth movement will not be similar which expected to be more noticeable in the growing than non-growing patients. If one desires to assess the effect of incisor inclination on the remodeling of point B, It is better to perform the present study on non-growing patients in order to eliminate the effect of growth on the results. Therefore, we recruited the adults subjects in both groups in order to eliminate the effect of growth on the sagittal position of point B in this study.

The results of the present study showed that, the incisal edge of the mandibular incisors were moved 4.83 mm forward, while the apex moved 1.25 mm backward during orthodontic treatment. This finding indicated that the movement generated due to the orthodontic treatment is a rotational movement with the center of rotation closer to the apex than to the bracket. The changes of point B which 1.42 mm backward and 0.54 mm upward was observed. These findings are coincident with those of Nanda [25] that "it is important to remember that skeletal landmarks are affected by dento-alveolar movement".

In the present study, the changes of point B decrease the SNB angle, which was found significant. However, the other study [16] evaluating the relationship between the sagittal position of point B and the SNB angle show that, despite bone remodeling, the SNB angle actually did not significantly change during treatment by cephalometric measurement. The possibly main reason was that their study lack of control. Because it is difficult to have a statistically significant difference in the change of 1 degree SNB compare to normal value which about 80 degree in included patients. Therefore, this study included subjects who required minimal maxillary anterior tooth movement found that the impact of incisor inclination on point B remodeled is statistically significant. Furthermore, in the present study, nasion was stability in adult patients, so it could be considered that the posterior movement of point B which resulted from bone remodeling associated with orthodontic tooth movement could lead to a real significant decrease in SNB angle.

## Conclusions

In a word, the position of point B was affected by local bone remodeling associated with retro-

clination of mandibular incisor in Class II division 2 malocclusion, these changes significantly affect the value of the SNB angle.

## Disclosure of conflict of interest

None.

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