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Assessment of Maxillary and Mandibular Incisal Inclination in Different Vertical Facial Types Using Cone Beam Computed Tomography: A Retrospective Study

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Abstract

Objectives: The aim of the study was to evaluate the maxillary incisal inclination and mandibular incisal inclination in different vertical facial patterns using cone-beam computed tomography.

Subjects and methods: out of 150 scans ninety-nine CBCT scans were carried to evaluate evaluate the maxillary incisal inclination and mandibular incisal inclination in different vertical facial patterns using cone-beam computed tomography for the three groups: Group I: normal vertical facial type. Group II: low vertical facial type. Group III: high vertical facial type.

Results: High angled group showed a higher inclination than Normal and Low angled groups. The inclination of the lower incisors assessed according to mandibular plane. There was a statistically a non-significant difference in mean incisors inclination in the three groups.

Conclusion: People have a high angle had more inclination than those with a normal angled groupsor low angled groups. The inclination of the lower incisors assessed according to mandibular plane.There was a statistically a non-significant difference in mean incisors inclination in the three groups.

keywords:Incisal inclination, CBCT, Facial type, Dolphin software.

Introduction

Skeletal malocclusion may be managed either by surgical treatment option or by orthodontic camouflaging option. In surgical treatment option, It is important to do presurgical orthodontic by decompensate the inclination of incisors to get more favorable post-surgical results **(1).**In contrast, the purely orthodontic option, clinicians do more compensation by labio-lingual inclination of incisors but within limitations of alveolar bone to prevent fenestration of alveolar bone**(2).**Therefore, compensatory mechanism of sagittal malocclusion and quantitative dento-alveolar evaluation can provide critical information on the orthodontic treatment **(3) (4).**

One of the essentials of orthodontic treatment planning is the position and inclination of the maxillary and mandibular incisors owing to the great impact on facial esthetic **(5)(3).**Therefore, antro-posterior positioning of incisors is limited by anatomy of the alveolar bone in maxillary and mandibular symphysis and periodontal status to prevent iatrogenic sequelae such as dehiscense or fenestration or resorption of incisors roots **(6) (7).**

The CBCT imaging technique has qualitative and quantitative evaluation of teeth and bone relationship **(8) (9).** Therefore, it can provide better visualization of the incisors and alveolar bone which give a better assessment of the incisal inclination within alveolar which is accurate and more reliable representations of incisal inclination and alveolar bone assessment.**(10).** There is a lack of studies regarding incisal inclination which is important for clinicians in anterior tooth movement in labio-lingual direction in

subjects with different vertical facial pattern. This may be due to the focus on the Inter-radicular cortical bone thickness at the vertical height in which mini-implants are commonly inserted for skeletal anchorage. The aim of the study was to evaluate the incisal inclination in different vertical facial types using conebeam computed tomography.

Subjects and methods

Study design:

The current study was retrospective study. It was conducted on unidentified ninety nineCone Beam Computed Tomography scans that were selected from the archive of Oral Radiology department, Faculty of Dentistry, Suez Canal University

Sample size calculation:

This power analysis used alveolar bone thickness as the primary outcome. Based upon the results of Raber A et al (2019)**(11),** the mean values for the three groups were 3.98, 3.43 and 4.48 mm, respectively. Using alpha (α) level of (5%), β level of 0.8 (Power = 80%) and assuming the standard deviation within each group = (1); the effect size (f) was (0.358) and the minimum estimated sample size was a total of 81 subjects. Sample size calculation was performed using G*Power version 3.1.9.2.

Sample selection:

Inclusion criteria:

1.Unidentified full skulls CBCTs.
2.Male or female patient's Scans.
3.Full set of permanent dentitions (no missing teeth except for the third molars).
4.The age of selected patient's scans was above 15 years old.
5.No orthodontics appliances seen in the CBCT scans.
6.CBCT of high quality with no artifact obscuring the region of the incisors.

Exclusion criteria:

1.CBCTs of patients have previous orthodontic treatment in the past.
2.CBCTs of patients have previous orthognathic surgery or plastic surgery in the past
3.CBCTs of patients have systematic bone disease or any syndrome.
4.A poor quality that made readings difficult to make.
5.CBCTs of patients have root resorption or impacted teeth.
6.images have a narrow field of vision and maxillofacial abnormalities or anomalies.

Grouping criteria:

Out of 150 CBCT scans we took 99 CBCT scans which was divided equally into three groups (33 scans in each group) according to their vertical facial pattern angles was extracted from reformatted lateral cephalometry from CBCT:

Group I: The inclusion criteria for this group is to have: SN/Mandibular plane angle is within the normal range. (32 +/- 4). Y axis to Frankfort plane angle is within the normal range. (61+/-4)

Frankfort to Mandibular plane angle is within the normal range. (25 +/-3) Gonial angle is within the normal range. (124 +/-5) Cranial base angle is within the normal range. (132 +/-5)

Group II: The inclusion criteria for this group is to have SN/Mandibular plane angle is decreased. (<27). Y axis to Frankfort plane angle is decreased. (<57). Frankfort to Mandibular plane angle is decreased. (<19). Gonial angle is decreased. (<119). Cranial base angle is decreased. (<127)

Group III: The inclusion criteria for this group is to have SN/Mandibular plane angle is increased. (>37). Y axis to Frankfort plane angle is increased. (>66). Frankfort to Mandibular plane angle is increased. (>29). Gonial angle is increased. (>129). Cranial base angle is increased. (>138)

Radiographic measurements:

The CBCT scans were performed to the long axis of each upper and lower incisor from the incisal edge to root apex. The axial inclination of maxillary incisor was measured relative to Frankfort horizontal plane, SN and palatal plane. The axial inclination of mandibular incisor was measured relative to mandibular plane.

Images from CBCT examinations was acquired in a digital DICOM format then imported to Dolphin software application (Version 11.5; Dolphin Imaging and Management Systems, Chatsworth, CA) where evaluation of maxillary and mandibular incisal inclination was carried out for the following groups: -

1. Tracing of reformatted lateral cephalometry from CBCT for each group.

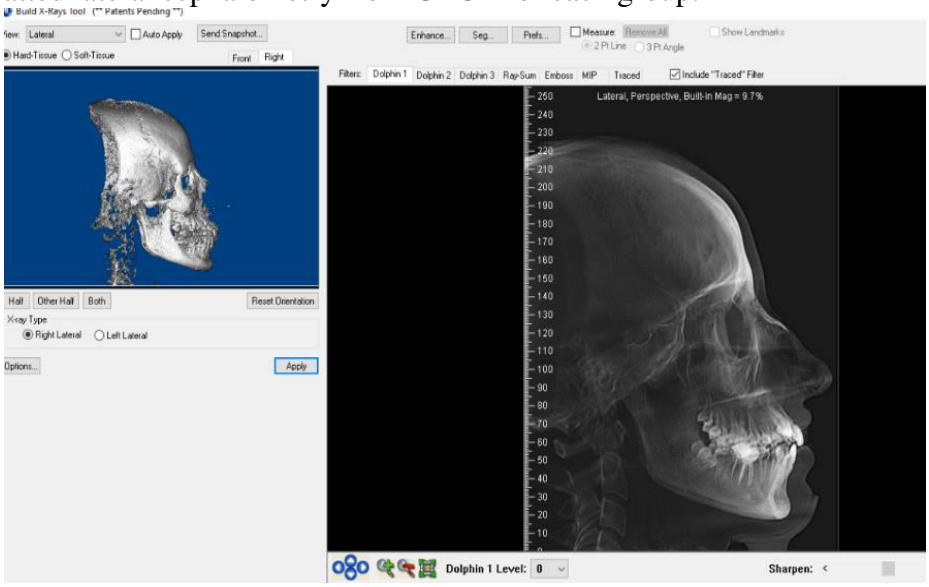

Figure 1, showing lateral cephalometry from CBCT

2. Angular measurements of incisal inclination of maxillary incisors related to SN plane for each group.
3. Angular measurements of incisal inclination of maxillary incisors related to Frankfort plane for each group.
4. Angular measurements of incisal inclination of maxillary incisors related to palatal plane for each group.
5. Angular measurements of incisal inclination of mandibular incisors related to mandibular plane for each group.

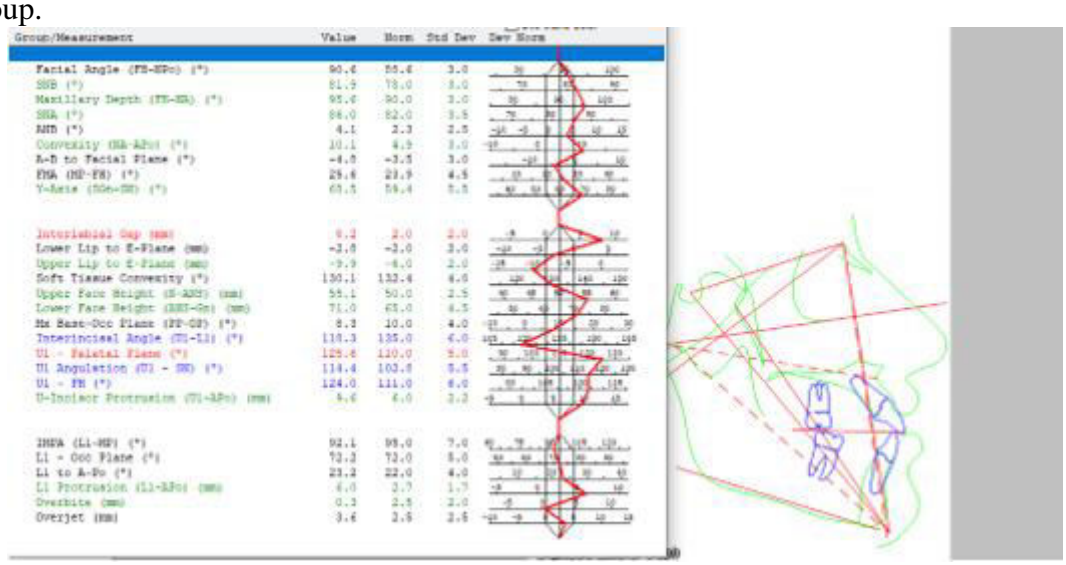

Figure 2, showing angular measurements of tracing lateral cephalometry

Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp). The Shapiro-Wilk test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation, median and Confidence interval of mean. Significance of the obtained results was judged at the 5% level. The used tests were One-way ANOVA test for normally distributed quantitative variables, to compare between more than two groups, and Post Hoc test (Tukey) for pairwise comparisons. Pearson coefficient to correlate between two normally distributed quantitative variables.

RESULTS

Angular measurements

Comparison between the three studied groups according to:

1. Angular measurements of incisal inclination of maxillary incisors related to SN plane for each group. U1/SN
2. Angular measurements of incisal inclination of maxillary incisors related to Frankfort plane for each group. U1/FH
3. Angular measurements of incisal inclination of maxillary incisors related to palatal plane for each group. U1/PL
4. Angular measurements of incisal inclination of mandibular incisors related to mandibular plane for each group. L1/MP

In U1/SN: inclination in normal group was 104.5 ± 3.50, Low was 102.6 ± 4.56, and in high was 108.1 ± 6.31. In U1/FH: inclination in normal group was 113.7 ± 3.01, Low was 110.1 ± 4.98, and in high was 118.7 ± 6.47. In U1/SN: inclination in normal group was 112.2 ± 2.26, Low was 108.0 ± 4.48, and in high was 116.5 ± 8.72. At U1/SN, U1/FH, and U1/PL: there was a statistically A significant difference in mean inclination in the three groups ($p<0.001^*$). High group showed a higher inclination than Normal and Low groups.

Comparison between the three studied groups according to inclination of lower incisors L1/MP in each site. In L1/MP: inclination in normal group was 96.37 ± 3.41, Low was 95.73 ± 2.95, and in high was 94.55± 3.37. there was a statistically a nonsignificant difference in mean inclination in the three groups (p=0.122).

Table 1 showing Comparison of upper incisors inclination between the three studied groups according to U1/SN, U1/FH and U1/PL, and L1/MP

	Normal (n = 33)	Low (n = 33)	High (n = 33)	F	p	Post Hoc Test		
						p_1	p_2	p_3
U1/SN	104.5 ± 3.50	102.6 ± 4.56	108.1 ± 6.31	8.664*	<0.001*	0.333	0.024*	<0.001*
U1/FH	113.7 ± 3.01	110.1 ± 4.98	118.7 ± 6.47	19.721*	<0.001*	0.030*	0.001*	<0.001*
U1/PL	112.2 ± 2.26	108.0 ± 4.48	116.5 ± 8.72	14.424*	<0.001*	0.027*	0.021*	<0.001*
L1/MP Mean ± SD.	96.37 ± 3.41	95.73 ± 2.95	94.55± 3.37	2.165	0.122	0.755	0.107	0.381

Data was expressed using Mean ± SD. SD: **Standard deviation**

F: **F for One way ANOVA test**, Pairwise comparison bet. each 2 groups was done using **Post Hoc Test (Tukey)**

p: p value for comparing between the three studied groups

p_1: p value for comparing between **Normal** and **Low**

p_2: p value for comparing between **Normal** and **High**

p_3: p value for comparing between **Low** and **High**

*: Statistically significant at $p \leq 0.05$

DISCUSSION

Inclination of maxillary and mandibular incisors:

The orthodontic treatment aimed at improving the slope of the maxillary incisors resulted in a better relationship with the face and growth axis. This correlation demonstrates the relationship between an optimal position of the maxillary incisors compared to the individual's matching vertical pattern.

our study showed the measurements at U1/SN, U1/FH, and U1/PL: there was a statistically A significant difference in mean inclination in the three groups ($p<0.001^{*}$). High group showed a higher inclination than Normal and Low groups. This was in agreement with **(5)**. On the other hand, (**12)**, maxillary incisor inclination did not connect with face and growth axis in an adult population prior to orthodontic treatment. However, there were larger associations in the posttreatment evaluation and demonstrated that after orthodontic treatment, all maxillary incisor measurements, including I/PP, I/SN, I/H, I/NBa, and I/NA, had substantial positive correlations, indicating a change into a more harmonic inclination relative to the growth pattern, and thus to face type.

The present study showed that measurements according to L1/MP: inclination in normal group was 96.37 ± 3.41, Low was 95.73 ± 2.95, and in high was 94.55± 3.37. there was a statistically a non-significant difference in mean inclination in the three groups (p=0.122). This was similar to **(14)**.Moreover, **(13)** showed that the axial inclinations of the upper and lower central incisors of the study had no significant differences (p>0.05).

CONCLUSION

People with a high angle had more upper inclination than those with a normal or low angle. The inclination of the lower incisors according to L1/MP there was a statistically a non-significant difference in mean inclination in the three groups.

So our study helps to provide the orthodontistsvia important knowledge about incisal inclination to plan proper treatment strategies in labio-lingual tooth movementtipping limitations to prevent iatrogenic sequelae such as dehiscence or fenestration.

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