

# THE ASSOCIATION BETWEEN LOWER CENTRAL INCISAL INCLINATION AND MORPHOLOGY OF THE SUPPORTING ALVEOLAR BONE — A LATERAL CEPHALOGRAM STUDY

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## ABSTRACT

**Aims & Objectives:** To study the relationship between mandibular central incisor inclination with the alveolar bone structure supporting it. **Materials and Methodology:** A total of 40 patients with mean age of 15.75 years with standard deviation of 2.67 were randomly selected from the Outpatient department of Karachi Medical & Dental College. As part of orthodontic treatment planning the patients were required to have lateral cephalogram investigation done which covers the required region of central incisors, supporting alveolar bone and mandible. The cephalometric parameters were designed and measured to indicate the inclination of lower central incisor and physical morphology of the adjacent alveolar bone structure. The statistical analysis was done using SPSS 14.0 for windows. A correlation analysis and simple linear regression analysis was done between the incisal inclination and morphology of alveolar bone structure. **Results:** A positive relation, which was very significant ( $p < 0.05$ ), was found between the incisal inclination and the contour of the alveolar bone structure. The thickness of lingual alveolar bone was reduced considerably when the incisal inclination increased buccally which can result in bony dehiscence during tooth movement. **Conclusion:** The morphology of supporting alveolar bone is correlated with the mandibular central incisal inclination.

**Keywords:** Cephalometric, alveolar bone

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## INTRODUCTION:

The foremost important thing for a successful orthodontic treatment is a thorough treatment planning and evaluation of treatment outcomes. The site of the lower incisors in relation to their supporting bone is a significant factor in orthodontic treatment planning; measurement of treatment progress, as well as determination of treatment outcome.<sup>1</sup> The period between 10 and 14 years of age is a stage at which corrective orthodontic treatment is usually practical. Therefore, the assessment of the changes in incisal positions occurring during this period could provide precious information for treatment planning and evaluation of post treatment stability.<sup>2</sup> Tooth arrangements showing central incisors with perfect axes are more attractive. Slight changes in the angulations of one or both lateral incisors do not influence attractiveness negatively.<sup>3</sup> Turk's study indicated that the determination of the centre of resistance location with consideration of alveolar bone

support, root morphology and tooth inclination would be more consistent with the final treatment outcome. The examination of the association between the individual centre of resistance and the line of action of force would be helpful in obtaining desired tooth movement.<sup>4</sup> It is established that the anteroposterior thickness of the alveolar bone in the symphysis region determines the distance available for orthodontic movement of the incisors. The labio/lingual inclination of the central incisor significantly correlates with the labiolingual inclination of the associate alveolar bone.<sup>5</sup> Numerous studies have shown that if the incisor root apex is moved against the cortical plate of the alveolar or beyond the alveolar, severe root resorption and bony dehiscence may occur.<sup>6, 7</sup> To evaluate the accurate position of the lower incisor root apex within the alveolar bone is therefore indispensable before orthodontic treatment. The alveolar bone is the part of the mandible that holds the tooth roots, periodontal ligament, and the lamina durra that

envelops the periodontal space. It is also the part of the mandible where most pathologic conditions occur. A traditional cephalographic radiograph is used to measure the incisal inclination with the alveolar bone. The lateral Cephalometric tracing is a universal way of measuring and analyzing dental malocclusion and anomalies before orthodontic treatment. Several studies investigating the relation of incisal inclination with the supporting alveolar bone morphology has been done in the past but no such study has been done in our setting. In our study Lateral Cephalometric radiograph is used for analysis and measurement of incisal inclination with the supporting alveolar bone in the mandibular symphysis area.

## MATERIALS AND METHODS

Study was done in Outpatient department of Orthodontic, Karachi Medical & Dental College, it was a cross sectional descriptive study of 6 month. Forty patients were randomly recruited for this study. The inclusion criteria were mild to moderate malocclusion without prior orthodontic treatment and acceptable oral hygiene without periodontal conditions. The patients were required to take lateral Cephalometric radiograph covering the lateral mandible and skull. Lateral Cephalometric x-ray was done from a single X-ray Lab to avoid inter examiner discrepancy.

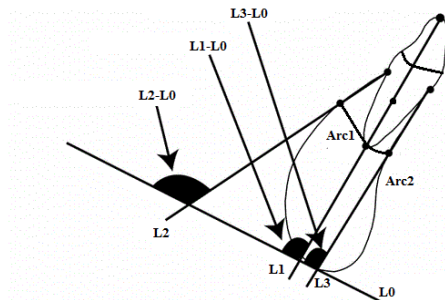


Figure 1-The land marks and reference lines used in the Lateral Cephalometric measurement L0: the plane through point Go and point Me; L1: a line through the midpoint of the incisor edge and the root apex; L2: a line through the most postero-superior point and the most posterior point of the mandibular alveolar bone; L3: a line through the most antero-superior point and the most posterior point of the mandibular alveolar bone. Arc1

and Arc2: the arc length between the root apex and lingual/ buccal wall of alveolar bone.

The following landmarks and reference lines were designated to indicate mandibular incisal positioning and its relation with the surrounding alveolar bone (Figure 1)<sup>5</sup>

Centre of rotation (R): This was defined as the midpoint of the incisor root position embedded in alveolar bone.

Line L0: a line through the point Me and tangent to the most superior point in inferior border of the mandibular body. L0 was constructed to serve as a reference plane.

Line L1: a line through the tip of incisal edge and the root apex of the lower central incisor. L1 was constructed to indicate the inclination of mandibular central incisor.

Line L2: a line tangent to the most superior- posterior point of the lingual surface of the mandibular alveolar bone. L2 was used to indicate the morphological contour of alveolar bone in lingual side.

Line L3: a line tangent to the most superior- posterior point of the labial surface of the mandibular alveolar bone. L3 was used to indicate the morphological contour of alveolar bone in labial side.

Arc1 and Arc2: a circle was formed with point R and the distance between R and the root apex as diameter. Arc1 was the circle fragment between T and the circle in setting with lingual surface of alveolar bone. Arc2 was the circle fragment between T and the circle inseting with the labial surface of alveolar bone. Arc1 and Arc2 were constructed to indicate the morphological relation between incisal root and alveolar bone.

## DATA ANALYSIS

For all statistical analysis SPSS 14.0 for windows was used. The level of significance was set at  $P < 0.05$ . Additionally, Pearson correlation analysis, i.e. central incisor angle versus lingual alveolar bone angle, central incisor angle versus labial alveolar bone angle, central incisor angle versus Arc1, central incisor angle versus Arc2, was performed. To reduce measurement error, one month after the first measurements, ten cases were randomly selected and measured again by the same examiner.

Results:

Descriptive analysis are shown in table I

	L1- L0/°	L2- L0/ °	L3- L0/ °	Arc1 /m m	Arc2 /m m
Mean	95.1 8	10 4.6	92. 65	5	5.6
Std. Devia tion	5.83	5.4 5	5.5 2	0.67	0.74
Mini mum	85	95	83	4	4
Maxi mum	105	11 3	10 1	6	7

Table 1 Descriptive analysis of lower incisor inclination and its relation to alveolar bone morphology (n=40)

	Pearson Correlation	P-Value
L1-L0/L2- L0	0.951	0.000**
L1-L0/L3- L0	0.995	0.000**
L1-L0/Arc1	-0.470	0.001*
L1-L0/Arc2	0.508	0.011*
Arc1/Arc2	0.678	0.000**

Table II

- Correlation coefficients analysis for the lower incisor inclination and its relationship to surrounding alveolar bone.

## DISCUSSION:

The anteroposterior position of the mandibular incisors affects the fullness of the lips. Not only it plays an important purposeful role in overbite stability, an ideal incisor inclination contributes to an attractive facial aesthetics.<sup>1, 13</sup> For reasons of both function and esthetics, it is therefore important to evaluate incisor inclinations before, during, and after orthodontic treatment. Many cephalometric goals for post treatment positions of the mandibular incisors have been advocated. Tweed stated that the mandibular incisors should create an angle from 85° to 95° with the mandible plane if the mandible plane to the Frankfort plane angle falls in the 22° to 29° range.<sup>12</sup> Some clinicians, however, have used Steiner chevrons to assess favorable positioning of the incisors.

Ricketts determines the ideal incisal position by the tips of the mandibular incisors to the A- pogonion line.<sup>13</sup>

Steiner and Calif first suggested the concept of ideal or standard inclinations for upper and lower incisors.<sup>14</sup> Over the subsequent years, some studies have established a remarkable uniformity for incisor inclinations in Caucasian populations, with mean values derived from 15 studies found to be 109° for the inclination of the upper incisors to the maxillary plane and 93° for the inclination of the lower incisors to the mandibular plane.<sup>15</sup> Along with the position on the palatal surface against which the lower incisors bite, the angle between the lower incisors and the palatal surface of the upper incisors is an imperative factor for determining overbite stability. Because the outline of alveolar bone surrounding the lower incisors, together with the mandibular symphysis in sagittal dimension is of the substantial shape with irregular curvatures, it is difficult to accurately describe, either mathematically or geometrically, the morphology of alveolar bone. Consequently, its relation with the positioning of lower incisors is difficult to determine. In this study, attempts were made to resolve this quandary. The lines tangent to either the most posterior or most anterior points in the outlines of the alveolar bone were constructed to reproduce the physical contour, and the segmental arc was measured to specify the thickness of the alveolar bone surrounding the lower central incisor (Figure 1). This quantitative assessment of physical morphology of alveolar bone made it possible to examine the correlative relation between the position of the lower incisor and morphology of alveolar bone.

It is important to note that the incisor angulations and tooth-size discrepancies can affect not only the anterior incisor relationship but also the buccal segment relationships.<sup>17-18</sup> Evaluation of incisor angulations and tooth-size harmony should be performed when the anterior and posterior occlusions do not occlude satisfactorily. Incorrect incisor angulations may be a significant contributor to the presence of a poor buccal segment and anterior relationship.<sup>19</sup> Inadequate consideration of upper and lower incisor angulations and tooth-size discrepancies could compromise anterior and buccal segment relationships during the finishing stages of orthodontic treatment.<sup>2</sup> Sangcharearn suggested that

skeletal Class II cases may have relatively upright upper incisors and proclined lower incisors.<sup>20</sup> A near normal occlusion could therefore be observed despite an underlying mild skeletal base discrepancy. When the skeletal base discrepancy becomes more severe, natural dentoalveolar compensation is insufficient to overcome the greater discrepancy between the maxillary and mandibular skeletal bases. Natural dentoalveolar compensation in Class II division 1 malocclusions may be normal to upright upper incisors and proclined lower incisors for the overjet to appear less severe. The proclination of the lower incisors increases the lower arch length, which could create problems with coordination between the upper and lower arches. In addition, it could also result in an inability to achieve an adequate overjet and overbite, or it may restrict adequate retraction of the upper incisors to close extraction spaces.<sup>20</sup>

In the present study, the labial/lingual inclination of the lower central incisor was correlated with the contour of the adjacent mandibular alveolar bone in both the labial and lingual regions. The linear regression analysis indicated that the adjacent alveolar bone contour correlated with the lower central incisor (Figure 3), suggesting that the morphology of alveolar bone seems to be affected by the tooth inclination. Another important and interesting phenomenon in this study was the distance between the incisor root apex to the labial/lingual wall of the alveolar bone. The correlation and regression analysis suggested a correlation between these two variables indicated by Arc1 and Arc2 (Table 2). Judging from these findings, one may come to a hypothesis that when the lower incisor tends to be more proclined, the lingual alveolar bone becomes thinner. This suggests that one should recognize the boundary limit for tooth movement during orthodontic treatment. When the lower incisors are to be proclined, a pre-treatment evaluation of the physical relationship between the incisor inclination and the adjacent alveolar bone could provide information about the limits of incisor movement, thus avoiding the root resorption caused by excessive incisal retraction.

#### **Conclusions:**

We conclude that there is significant correlation between the inclination of the lower central incisor and its associated alveolar bone shape. The thickness of supporting alveolar bone is critical in orthodontic treatment. The morphology of the alveolar crest in the lower central incisor may be affected by the incisor inclination. The lower central incisor root apex was closer to the lingual alveolar crest when it was buccal-inclined. The lower incisor position is important and should be considered in the orthodontic treatment plan.

#### **References**

1. Aasen TO, Espeland L (2005). An approach to maintain orthodontic alignment of lower incisors without the use of retainers. *Eur J Orthod*, 27(3): 209–214.
2. Ceylan I, Baydas B, Bolukbasi B (2002). Longitudinal cephalometric changes in incisor position, overjet, and overbite between 10 and 14 years of age. *Angle Orthod*, 72(3): 246–250.- 222 - *Int J Oral Sci*, 1(4): 217–223, 2009
3. Wolfart S, Thormann H, Freitag S, Kern M (2005). Assessment of dental appearance following changes in incisor proportions. *Eur J Oral Sci*, 113(2): 159–165.
4. Türk T, Elekdag-Türk S, Dincer M (2005). Clinical evaluation of the centre of resistance of the upper incisors during retraction. *Eur J Orthod*, 27(2): 196–201.
5. Yamada C, Kitai N, Kakimoto N, Murakami S, Furukawa S, Takada K (2007). Spatial relationships between the mandibular central incisor and associated alveolar bone in adults with mandibular prognathism. *Angle Orthod*, 77(5): 766–772.
6. Apajalahti S, Peltola JS (2007). Apical root resorption after orthodontic treatment-a retrospective study. *Eur J Orthod*, 29(4): 408–412.
7. Richmond S, Klufas ML, Sywanyk M (1998). Assessing incisor inclination: a non-invasive technique. *Eur J Orthod*, 20(6): 721–726.
8. Bohm B, Hirschfelder U (2000). Localization of lower right molars in a panoramic radiograph, lateral cephalogram and dental CT. *J Orofac Orthop*, 61(4): 237–245.
9. Gahleitner A, Watzek G, Imhof H (2003). Dental CT: imaging technique, anatomy, and pathologic conditions of the jaws. *Eur Radiol*, 13(2): 366–376.

10. Gahleitner A, Podesser B, Schick S, Watzek G, Imhof H (2004). Dental CT and orthodontic implants: imaging technique and assessment of available bone volume in the hard palate. *Eur J Radiol*, 51(3): 257–262.
11. Robinson S, Czerny C, Gahleitner A, Bernhart T, Kainberger FM (2002). Dental CT evaluation of mandibular first premolar root configurations and canal variations. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*, 93(3): 328–332.
12. Tweed C (1954). Frankfort-mandibular incisor angle in orthodontic diagnosis, treatment planning and prognosis. *Angle Orthod*, 24(3): 121–169.
13. Al-Nimri KS (2003). Changes in mandibular incisor position in Class II Division 1 malocclusion treated with premolar extractions. *Am J Orthod Dentofacial Orthop*, 124(6): 708–713.
14. Steiner C, Calif B (1953). Cephalometrics for you and me. *Am J Orthod*, 39(10): 729–755.
15. Hamdan AM, Rock WP (2001). Cephalometric norms in an Arabic population. *J Orthod*, 28(4): 297–300.
16. Shah N, Spary DJ, Rock WP (2005). A jig for measuring incisor inclination. *Eur J Orthod*, 27(3): 252–257.
17. Van Steenberghe E, Burstone CJ, Prahl-Andersen B, Aartman IH (2006). Influence of buccal segment size on prevention of side effects from incisor intrusion. *Am J Orthod Dentofacial Orthop*, 129(5): 658–665.
18. Freitas MR, Castro RC, Janson G, Freitas KM, Henriques JF (2006). Correlation between mandibular incisor crown morphologic index and postretention stability. *Am J Orthod Dentofacial Orthop*, 129(4): 559–561.
19. Melgaco CA, de Sousa Araujo MT, de Oliveira Ruellas AC (2007). Mandibular permanent first molar and incisor width as predictor of mandibular canine and premolar width. *Am J Orthod Dentofacial Orthop*, 132(3): 340–345.
20. Sangcharearn Y, Ho C (2007). Effect of incisor angulation on overjet and overbite in Class II camouflage treatment. A tyodont study. *Angle Orthod*, 77(6): 1011–1018.
21. Tohnak S, Mehnert A, Crozier S, Mahoney M (2006). Synthesizing panoramic radiographs by unwrapping dental CT data. *Conf Proc IEEE Eng Med Biol Soc*, 1: 3329–3332.
22. Bernaerts A, Vanhoenacker FM, Chapelle K, Hintjens J, Parizel PM (2006). The role of dental CT imaging in dental implantology. *JBR-BTR*, 89(1): 32–42.