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To Evaluate the Width and Height of Anterior Alveolar Dimension Relative to the Root Apex of Incisors

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ABSTRACT

Introduction: The amount of alveolar bone on the palatal and labial surface of a tooth plays an important role in orthodontic tooth movement. Ideal post treatment results are obtained when the tooth movement is carried out within the confines of the alveolar bone.
Material and methods: Pre-treatment lateral cephalograms of 80 subjects were randomly selected and divided into four groups of 20 each: Group 1: UI to NA= 22°; LI to NB= 25°; Group 2: UI to NA = < 22°; LI to NB = < 25°; Group 3: UI to NA= 23°to 30° ; LI to NB= 26° to 30° ;Group 4: UI to NA= 31°to 35° ; LI to NB= 31° to 35° and measurements were statistically analysed.
Results: Significant differences were found among all the parameters, however these differences varied from one group to another.
Conclusion: The amount of alveolar bone present on the palatal surface of retroclined incisors is more as compared to the labial surface while as in labially inclined incisors, alveolar bone present on the labial surface is more than the palatal surface. Also, the amount of alveolar bone height is more in labially inclined incisors as compared to retroclined incisors.

Keywords: Alveolar dimensions, root apex, long axis, retroclined, proclined.

INTROUCTION

A good orthodontic correction is considered to be one in which the upper and lower incisors are upright on the basal bone. An orthodontist has to ensure that the results achieved post treatment are stable and there are no chances of relapse. It is important to have an excellent periodontal support around the newly corrected tooth position, for which the incisors should be positioned in the middle of alveolar process between the labial and lingual/ palatal cortical plates[1].

Alveolar base width is considered to be complete when the permanent teeth erupt into their final position in the oral cavity. In order to avoid any bone loss or root resorption due to orthodontic tooth movement, the movement should be carried within the alveolar bone without hampering the relationship between the roots and the cortical plates[2]. A tooth angulation that is too lingual or too buccal to the cortical plate may adversely affect the final outcome of the treatment.

The remodelling capacity of alveolar bone declines from the height of alveolar process in the direction of root apex[3]. This might act as a disadvantage to orthodontic tooth

movement at the level of root apex. Hence, the thickness of anterior alveolus and labiolingual movement of incisors should be considered while forming the treatment plan especially when excessive retraction or proclination of incisors is to be planned.
So, the aims and objectives of the present study were to evaluate the width and height of anterior alveolar dimension relative to the root apex of incisors.

MATERIAL AND METHODS

The study was conducted on the subjects who visited the department for seeking orthodontic treatment. The sample size was calculated using Daniel's formula[4]. Lateral cephalograms of 80 subjects were divided into 4 groups depending upon the inclination of upper and lower incisors.

- Group 1: UI to NA= 22°; LI to NB= 25°
- Group 2: UI to NA = < 22°; LI to NB = < 25°
- Group 3: UI to NA= 23°to 30°; LI to NB= 26° to 30°
- Group 4: UI to NA= 31°to 35°; LI to NB= 31° to 35°

The following was the selection criteria: -

INCLUSION CRITERIA:

1. High quality pre-treatment lateral cephalograms.
2. Subjects were in the age range between 16-26years.
3. The patient should be of Himachali ethnic origin from past three generations.

EXCLUSION CRITERIA:

1. No previous orthodontic treatment.
2. No craniofacial syndromes.
3. No history of maxillofacial trauma.

After obtaining standardized lateral cephalograms of the subjects, manual tracing was done on the cephalograms. Various anatomic landmarks were located on each tracing and by using these landmarks various linear and angular measurements were done as shown in **Table I and Figure 1**. The following landmarks were identified: Nasion (N), Anterior nasal spine (ANS), Posterior nasal spine (PNS), Point A (A), Point B(B), Upper incisal apex (UIA) and lower incisor apex (LIA). The dimensions of maxillary and mandibular anterior alveolus were measured using the method described by Handelman (1996)[5].

Table I: Linear measurements used in the study

LANDMARKS	DESCRIPTION
UPPER POSTERIOR ALVEOLUS WIDTH (UP)	The distance from the apex of the maxillary central incisor to the limit of the palatal cortex along a line drawn through the apex parallel to the palatal plane (ANS-PNS)
UPPER ANTERIOR ALVEOLUS WIDTH (UA)	The distance from the apex of the maxillary central incisor to the limit of the labial cortex along a line drawn through the apex parallel to the palatal plane.
UPPER ANTERIOR ALVEOLUS HEIGHT (UH)	The shortest distance between the maxillary central incisor apex and the palatal plane.
LOWER POSTERIOR ALVEOLUS WIDTH (LP)	The distance from the apex of the mandibular central incisor to the limit of the lingual cortex along a line drawn through the apex parallel to the occlusal plane.
LOWER ANTERIOR ALVEOLUS WIDTH (LA)	The distance from the apex of the mandibular central incisor to the limit of the labial cortex along a line drawn through the apex parallel to the occlusal plane.
LOWER ANTERIOR ALVEOLUS HEIGHT (LH)	The shortest distance from the apex of mandibular central incisor apex to the lowest point on the mandibular symphysis that is trabsected by a line parallel to the occlusal plane.

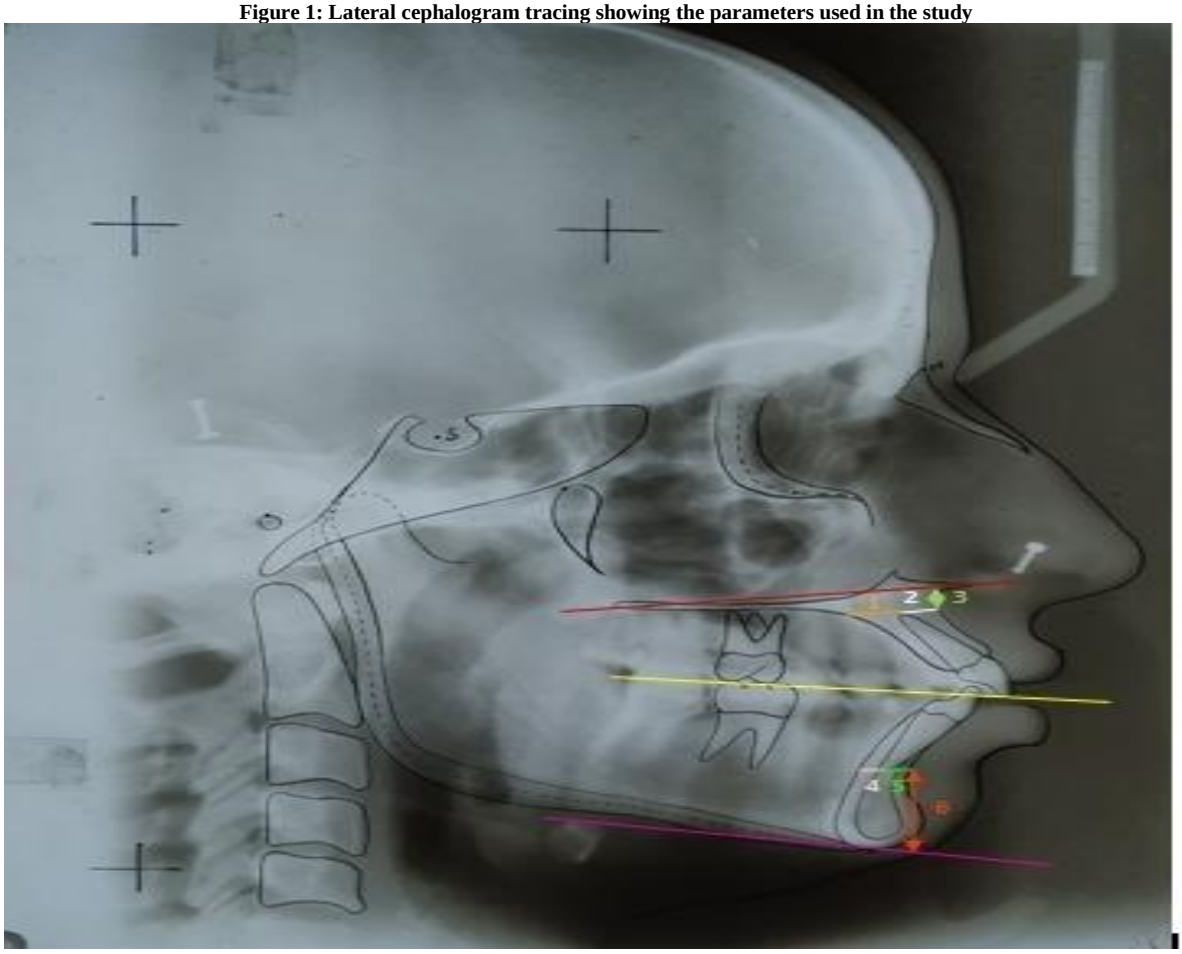
STATISTICAL ANALYSIS

All the measurements were analysed using SPSS software version 21. Pearson correlation coefficient and ANOVA were done to analyze the results after the descriptive statistics. The level of statistical significance used in this study was set at $p \leq 0.05$.

METHOD ERROR

The methodology was performed by the same examiner and was examined twice with an interval of one week difference. Assessment of intraexaminer reliability was done using Kappa statistics which showed perfect agreement (Kappa = 0.80-1.00, $p<0.001$).

Figure 1: Lateral cephalogram tracing showing the parameters used in the study



1)Upper posterior alveolus width (UP), 2) Upper anterior alveolus width (UA), 3) Upper anterior alveolus height (UH), 4) Lower posterior alveolus width (LP), 5) Lower anterior alveolus width (LA), 6) Lower anterior alveolus height (LH)

RESULTS

The descriptive statistics and comparison of the variables in all the four groups using one way ANOVA test are shown in Table II, Graph 1 and Graph 2. On Comparison of various parameters among the four groups, statistically significant differences were found ($p<0.05$) and to further evaluate the significant parameters within the four groups, post hoc Tukey's test was done as shown in Table III.

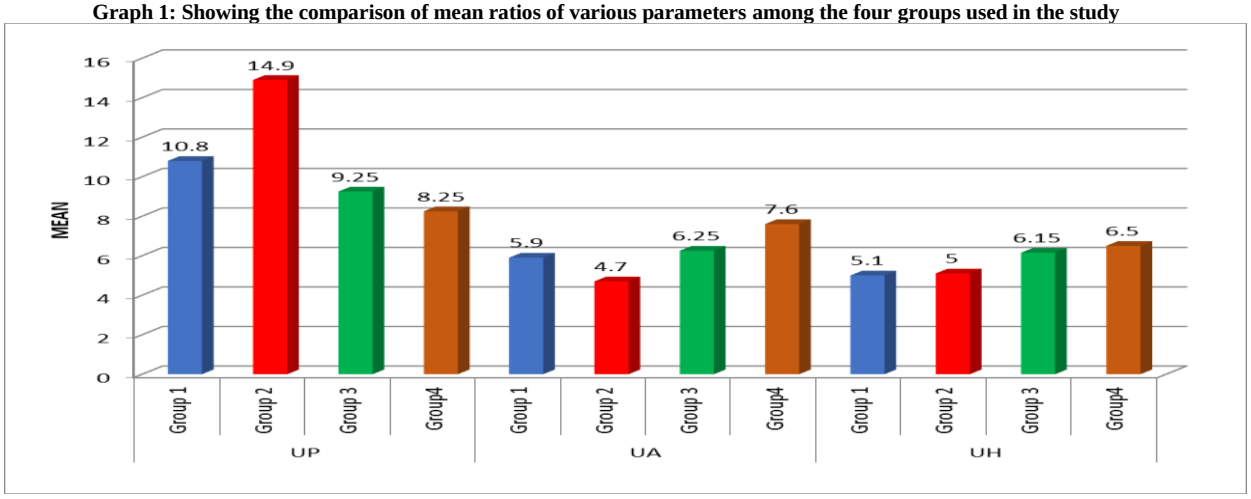
Table II: Comparison of mean values of different parameters among the four groups.

Parameters		N	Mean	Standard Deviation	Standard Error	F value	P value
UP	Group 1	20	10.80	.76	.17	280.19	0.001*
	Group 2	20	14.90	.91	.20		
	Group 3	20	9.25	.78	.17		
	Group4	20	8.25	.63	.14		
UA	Group 1	20	5.90	.78	.17	50.86	0.001*
	Group 2	20	4.70	.86	.19		
	Group 3	20	6.25	.71	.16		
	Group4	20	7.60	.59	.13		
UH	Group 1	20	5.10	.79	.17	85.65	0.001*
	Group 2	20	5.00	.71	.16		
	Group 3	20	6.15	.74	.16		
	Group4	20	6.50	.82	.18		

Table II To Be Continued…							
LP	Group 1	20	3.90	.64	.14	5.34	0.002*
	Group 2	20	4.65	.87	.19		
	Group 3	20	4.35	.74	.16		
	Group4	20	3.85	.67	.15		
LA	Group 1	20	5.10	.79	.17	18.90	0.001*
	Group 2	20	5.00	.71	.16		
	Group 3	20	6.15	.74	.16		
	Group4	20	6.50	.82	.18		
LH	Group 1	20	15.70	.92	.20	86.44	0.001
	Group 2	20	14.35	.74	.16		
	Group 3	20	17.80	.95	.21		
	Group4	20	18.10	.78	.17		

p>0.05 – Not Significant; p < 0.05 – Significant; p <0.001 – Highly Significant

Graph 1: Showing the comparison of mean ratios of various parameters among the four groups used in the study



Graph 2: Showing the comparison of mean ratios of various parameters among the four groups used in the study

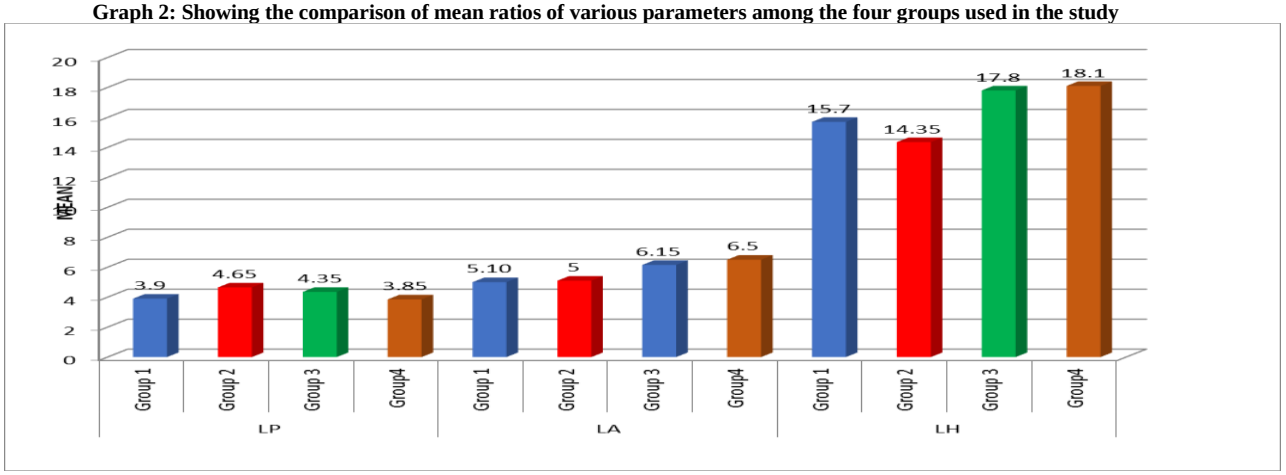


Table III: Multiple Comparison of different parameters among the four groups.

Dependent Variable	(I) V1	(J) V1	Mean Difference (I-J)	Standard Error	Sig.
UP	Group 1	Group 2	-4.10*	.24	.000
		Group 3	1.55*	.24	.000
		Group 4	2.55*	.24	.000
	Group 2	Group 1	4.10*	.24	.000
		Group 3	5.65*	.24	.000
		Group 4	6.65*	.24	.000
	Group 3	Group 1	-1.55*	.24	.000
		Group 2	-5.65*	.24	.000
		Group 4	1.00*	.24	.001
	Group 4	Group 1	-2.55*	.24	.000
		Group 2	-6.65*	.24	.000
		Group 3	-1.00*	.24	.001

Table III To Be Continued…					
UA	Group 1	Group 2	1.20*	.23	.000
		Group 3	-.35	.23	.455
		Group 4	-1.70*	.23	.000
	Group 2	Group 1	-1.20*	.23	.000
		Group 3	-1.55*	.23	.000
		Group 4	-2.90*	.23	.000
	Group 3	Group1	.35	.23	.455
		Group 2	1.55*	.23	.000
		Group 4	-1.35*	.23	.000
	Group 4	Group 1	1.70*	.23	.000
		Group 2	2.90*	.23	.000
		Group 3	1.35*	.23	.000
UH	Group 1	Group 2	2.60*	.25	.000
		Group 3	1.50*	.25	.000
		Group 4	-1.15*	.25	.000
	Group 2	Group 1	-2.60*	.25	.000
		Group 3	-1.10*	.25	.000
		Group 4	-3.75*	.25	.000
	Group 3	Group 1	-1.50*	.25	.000
		Group 2	1.10*	.25	.000
		Group 4	-2.65*	.25	.000
	Group 4	Group 1	1.15*	.25	.000
		Group 2	3.75*	.25	.000
		Group 3	2.65*	.25	.000
LP	Group 1	Group 2	-.75*	.23	.010
		Group 3	-.45	.23	.226
		Group 4	.05	.23	.997
	Group 2	Group 1	.75*	.23	.010
		Group 3	.30	.23	.575
		Group 4	.80*	.23	.005
	Group 3	Group 1	.45	.23	.226
		Group 2	-.30	.23	.575
		Group 4	.50	.23	.150
	Group 4	Group 1	-.05	.23	.997
		Group 2	-.80*	.23	.005
		Group 3	-.50	.23	.150
LA	Group 1	Group 2	-.10	.24	.977
		Group 3	-1.15*	.24	.000
		Group 4	-1.50*	.24	.000
	Group 2	Group 1	.10	.24	.977
		Group 3	-1.05*	.24	.000
		Group 4	-1.40*	.24	.000
	Group 3	Group 1	1.15*	.24	.000
		Group 2	1.05*	.24	.000
		Group 4	-.35	.24	.483
	Group 4	Group 1	1.50*	.24	.000
		Group 2	1.40*	.24	.000
		Group 3	.350	.24	.483
LH	Group 1	Group 2	1.35*	.27	.000
		Group 3	-2.10*	.27	.000
		Group 4	-2.40*	.27	.000
	Group 2	Group 1	-1.35*	.27	.000
		Group 3	-3.45*	.27	.000
		Group 4	-3.75*	.27	.000
	Group 3	Group 1	2.10*	.27	.000
		Group 2	3.45*	.27	.000
		Group 4	-.30	.27	.686
	Group 4	Group 1	2.40*	.27	.000
		Group 2	3.75*	.27	.000
		Group 3	.30	.27	.686

DISCUSSION

The height and width of the alveolar bone play an important role in orthodontic tooth movement. It is believed that the boundaries set by the cortical plates in the alveolar bone act as orthodontic walls and the tooth movement should be carried out within these walls[6]. Excessive labial or palatal

inclination of incisor in its bony socket post treatment can lead to unstable results and insufficiency of the maxillary alveolar width could be considered as a risk associated with root resorption during orthodontic treatment[7]. Hence, it is important for an orthodontist to keep in mind the amount of bone available on the labial and palatal surface of a tooth. Apart from the width, the height of the alveolar bone also plays an important role in determining the extrusive and intrusive movement of a tooth. So, in the present study evaluation of the width and height of anterior alveolar dimension relative to the root apex of incisors was done.

In this study, 80 cephalograms were divided into four groups and the anteroposterior and vertical dimensions of the anterior alveolar dimensions were measured. The groups were analysed separately and significant difference was noted in the upper posterior alveolus width (UP). It was found to be highest in Group 2(14.90) and lowest in Group 4(8.25) as shown in Table II and Graph 1. The reason for this being that more palatally inclined incisors have thick alveolar bone at their posterior aspect and also, the labially inclined incisors have lesser alveolar bone on their palatal side. This implies that while retracting the incisors, an orthodontist must keep in mind that the root of the teeth has to be kept within the confines of the alveolar bone so as to avoid an iatrogenic risks like root resorption or bone loss. The results of this study were in accordance with the study done by Tian yu-lou et al [8] *on* Korean population as they concluded that palatally inclined incisors have thicker alveolar bone on their posterior aspect.

Further, the results showed that values of upper anterior alveolus width (UA) were found to be highest in Group 4(7.60) and lowest in Group 2(4.70) as shown in Table II and Graph 1 indicating that with more labial inclination of incisors, the alveolar bone is thick anteriorly. The results of this study were in agreement with the study done by Scocate AC at al [9]. He also concluded that labially inclined incisors have more alveolar bone on the labial aspect and for patients who have maxillary dentoalveolar protrusion with flaring anterior teeth, the larger volume of bony support allows easy retraction of the anterior teeth with some tipping.

Moreover, the mean values of upper alveolar height (UH) were found to be statistically different in all the groups. It was highest in Group 4(6.50) and lowest in Group 2(5.00) as shown in Table II and Graph 1. The reason being that the more retroclined the incisors, lesser is the bone available vertically. The results of this study were in agreement with the study done by Tian yu-lou et al [8] and Scocate AC at al [9]. They concluded that in palatally inclined incisors, the amount of alveolar bone present vertically is less as compared to that in labially inclined incisors. The vertical thickness of the alveolar bone plays an important role when intrusion or extrusion of the teeth is to be carried out.

The results of the present study showed statistically significant difference in the mean values of lower posterior alveolus width (LP). The values were found to be highest for Group 2(4.65) and lowest for Group 4(3.85) as shown in Table II and Graph 2. This is because the lingually inclined incisors have thick alveolar bone on their posterior aspect. The result of this study was in agreement with the study done by Nor M.M et al [10] and Yamanda C et al [11]. They concluded that the lower incisors that are more lingually placed have more alveolar bone on their lingual aspect while as the labially placed incisors have less alveolar bone on their lingual aspect.

Further, the results of the present study showed statistically significant difference in the values of lower anterior alveolus width (LA). The highest values were found in Group 4(6.50) and lowest in Group 2(5.00) as shown in Table II and Graph 2. The reason for this is that labially inclined incisors have thicker alveolar bone on their anterior aspect. The results obtained were in accordance with the study done by

Yamanda C et al [11] and Yu Q et al [12]. They also concluded that the amount of alveolar bone on the labial surface is more in labially inclined lower incisors and less in lingually inclined incisors. Orthodontic tooth movement beyond the confines of the available alveolar bone can result in alveolar bone loss, bone resorption or periodontal issues like fenestrations and dehiscence.

Moreover, the results obtained in the present study showed significant differences in the values of lower alveolar height (LH). The values were found to be highest for Group 4(18.10) and lowest for Group 2(14.35) as shown in Table II and Graph 2. This is because, with the retroclination of incisors the height of alveolar bone available vertically decreases. The results of this study were in accordance with the study done by Nor M.M et al [10], Yamanda C et al [11] and Yu Q et al [12]. In their study, they also found that lingually inclined lower incisors have less bone available vertically as compared with the labially inclined incisors . The knowledge of the amount of vertical bone available plays an important role for the orthodontist where intrusive or extrusive movements of the incisors is to be carried out.

Therefore, from the present study it can be concluded that the amount of available alveolar bone should be always considered whenever tooth movements like retraction, proclination, intrusion or extrusion are to be carried out . Any tooth movement carried beyond the limits of the alveolar bone can result in iatrogenic risks including bone loss & periodontal issues.

CONCLUSION

The amount of alveolar bone present on the palatal surface of retroclined incisors is more as compared to the labial surface.

In labially inclined incisors, the amount of alveolar bone present on the labial surface is less than the palatal surface.

The amount of alveolar bone height is more in labially inclined incisors as compared to retroclined incisors.

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