Iranian Journal of Orthodontics, Vol. 9, 2014, 8-12

ORIGINAL ARTICLE

Relationship between Mid-palatal Bone Thickness and Facial Height Using CBCT for Orthodontic Mini-implant

S. NaghiNejad Ahmadi
Post-graduate Student of orthodontics, Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran
M. Kochoei
Associate Professor of orthodontics, Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran

Abstract

Aim: Orthodontic mini-implants have been incorporated into orthodontic treatment modalities. Adequate bone at mini-implant placement site can influence the success or failure of anchorage. The aim of the present study was to determine the thickness of bone in the maxillary mid-palatal area at predetermined points for the placement of orthodontic mini-implants using Cone Beam CT technique in order to evaluate the relationship of these values with the facial height.
Materials and methods: A total of 161 patients, consisting of males (39.32%) and females (60.86%), were evaluated in the present study; 38% of the subjects had normal facial height, 29% had short face and 33% had long face. In order to determine which patient belonged to which facial height category, i.e. normal, long or short, two angular and linear evaluations were used: the angle between S-N and Go-Me lines and the S-Go/N-Me ratio. Twenty points were evaluated in all the samples. First the incisive foramen was located. The para-coronal cross-sections were prepared at distances of 4, 8, 16 and 24 mm from the distal wall of the incisive foramen and on each cross-section the mid-sagittal and para-sagittal areas were determined bilaterally at 3- and 6-mm distances (a total of 5 points). The thicknesses of the bone were determined at the predetermined points.

Results: Statistical analysis did not show significant differences between three different facial height groups at none of the 20 points**.**

Conclusion: The present study did not find any relationship between palatal bone thickness and facial height. Further studies with larger sample size are necessary to evaluate the relationship between the thickness of bone and facial height.

Key words: Anchorage; Cone beam CT; Facial height; Cortical Bone thickness.

Correspondence: S.NaghiNejad Ahmadi
Post-graduate Student of orthodontics, Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran

Introduction

Provision of anchorage is one of the most challenging aspects of orthodontic treatment planning. Routine and conventional anchorage techniques are generally dependent on patient compliance and usually result in untoward reciprocal tooth movements. To overcome such a problem, orthodontic mini-implants have been incorporated into orthodontic treatment modalities. Adequate bone at mini-implant placement site can influence the success or failure of anchorage; therefore, a large number of studies have been carried out to determine appropriate locations for stability of mini-implants. It is necessary to have knowledge about the thickness of bone to select a proper length for mini-implants to avoid perforation of the nasal cavity.[1-9]

Since the facial height is related to morphologic changes induced by genetics and oral breathing during childhood, it is rational that the thickness of bone in patients with different facial heights will be different .[10-11] In a clinical study, one of the parameters determining the success of mini-implants was reported to be the facial height.[12]

The aim of the present study was to determine the thicknesses of bone in the mid-palatal area of the maxilla with the use of Cone beam CT technique in patients with different facial heights. Such a study with this sample size has not been carried out to date and the present study was carried out in a population of Iranian patients, referred to the Department of Radiology, Faculty of Dentistry, Tabriz University of Medical Sciences.

Material &Methods

The present descriptive study was carried out on Cone beam CT images of patients referred to the Department of Radiology, Tabriz Faculty of Dentistry, in 2013-2014. The inclusion criteria consisted of all the patients referred to the radiology department for any reason necessitating Cone beam CT imaging, with favorable image quality. The exclusion criteria consisted of the following: malformations or syndromes, anomalies with potential effects on facial height, systemic diseases and use of specific medications (such as corticosteroids), a history of trauma to and surgery of the study area, patients in the mixed dentition period and presence of impacted teeth in the palatal area.

The Cone beam CT images of all the subjects were taken using a New Tom VGI Cone beam CT unit with the following specifications: 15×15-cm field of view; 110 kVp, 1-20 mA, scan time of 18 seconds and voxel size of 0.3 mm. Then the images were reconstructed with NNT viewer software. Twenty points were evaluated in all the samples (Figure 1).

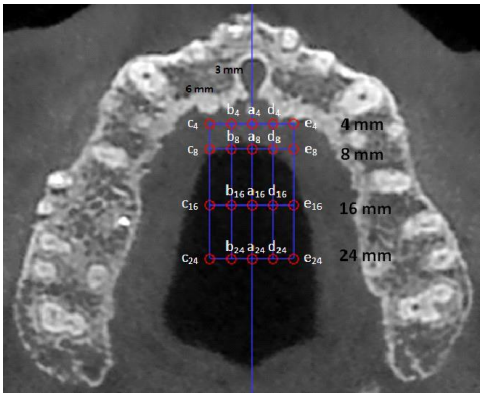
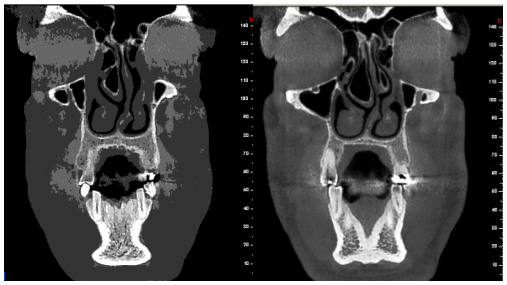
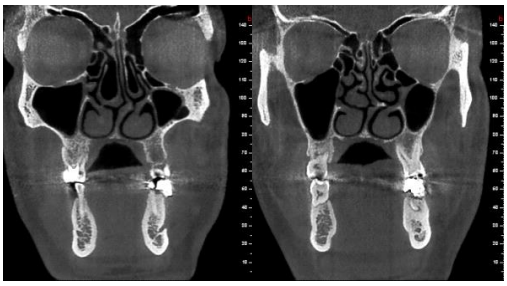


Figure 1. Reference points and lines for measuring bone and soft tissue thicknesses.



4 mm 8 mm



16 mm 24 mm

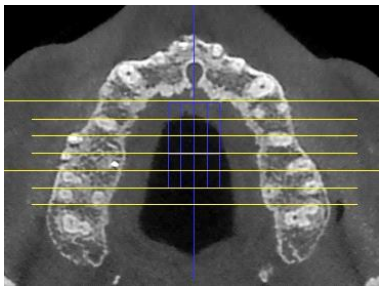


Figure 2. Reconstructed coronal cross-sections at 24-, 16-, 8- and 4-mm distances distal to the posterior wall of the incisive foramen.



Figure 3. A sample of measurements on each cross-section.

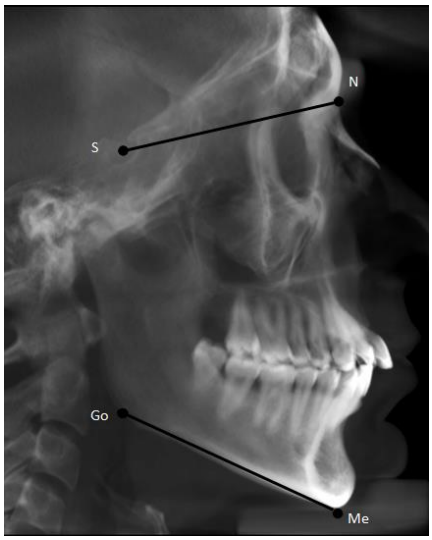


Figure 4. Lateral scout view with it`s angular measurements.

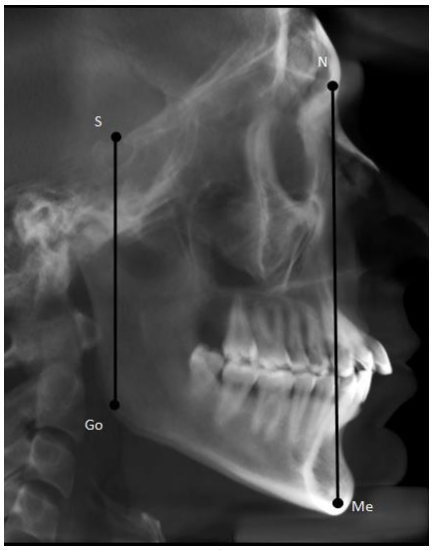


Figure 5. Lateral scout view with it`s linear measurents.

First, the incisive foramen was located by placing the sagittal and axial views next to each other. The para-coronal cross-sections were prepared at 4, 8, 16 and 24 mm distances, respectively, from the posterior wall of the incisive foramen. On each cross-section, the mid-sagittal and para-sagittal areas were determined bilaterally at 3- and 6-mm intervals (5 points on the whole) (Figure 2). At the pre-determined areas the thicknesses of bone were determined (Figure 3). All the measurements were made perpendicular to the tissue surface, in milimeter. The images were displayed on a 19-inch Philips LCD (liquid crystal display) monitor of a desktop computer, with a resolution of 1024 ×1024 and 32-bit and visualized by an observer twice with an interval of 2 weeks in a windowless dimly lit room.

Patients' lateral views taken as a scout (figure 4 and figure 5) were used to assign patients to normal, long and short face groups with the use of angular (the angle between Sella-Nasion and Gonion-Menton lines) and linear (the ratio of Sella-Gonion/Nasion-Menton) evaluations. In relation to linear evaluation, subjects in which the Sella-Gonion/Nasion-Menton ratio was less than 61% were assigned to the long face group; subject with a ratio between 61 and 69 percent were assigned to the normal group; and subjects in which this ratio was over 69% were placed in the short face group. In relation to angular evaluation, subjects in which the angle between Sella-Nasion and Gonion-Menton lines was less than 27° were placed in the short face group; subjects with a degree between 27 and 37 were placed in the normal face group; and patients with a degree greater than 37° were placed in the long face group. Subjects who were placed in two different groups by the angular and linear evaluations were excluded from the study.[13]

Statistical analysis were carried out with software SPSS 17, 1-way analysis of variance was used for intergroup comparisons.

Cronbach's alpha was used to evaluate intra-group correlation to test the validity of the measurement tool. Cronbach's alpha was calculated for all the 20 points on palatal bone so that the reproducibility of measurements could be determined for evaluation of the accuracy of measurement tool. Alpha values greater than 0.75 indicate the validity of measurement tool, which was >0.75 in the present study for intra-group correlation, indicating that the measurement tool was adequately accurate for measurements (0.89).

Results

A total of 63 (39.32%) of the subjects were male and 98 (60.86%) were female. There was almost a uniform distribution of different facial heights, with 38% of the subjects with normal face, 29% with short face and 33% with long face.

Table 1. Comparison of bone thickness at the predetermined points in terms of facial height

	Normal	Short	Long	ANOVA	
	Mean± SD	Mean± SD	Mean± SD	f	p value
a_4	6.86±1.92	7.11±1.96	7.14±1.98	0.36	0.70
a_8	5.71±1.79	5.77±1.41	5.58±1.53	0.19	0.83
a_{16}	5.35±1.64	5.78±1.72	5.09±1.38	2.45	0.09
a_{24}	5.92±1.57	6.10±1.69	5.70±1.67	0.78	0.46
b_4	5.53±2.22	5.25±2.27	5.67±2.04	0.49	0.62
b_8	3.77±1.75	3.71±1.72	3.59±1.39	0.17	0.85
b_{16}	2.62±1.27	2.97±1.36	2.49±1.16	1.94	0.15
b_{24}	2.63±1.21	2.85±1.19	2.55±1.22	0.84	0.44
c_4	5.60±2.48	5.17±2.49	5.88±2.10	1.12	0.33
c_8	3.12±1.80	2.99±1.71	2.97±1.46	0.13	0.88
c_{16}	1.62±0.97	1.85±1.16	1.52±0.81	1.38	0.25
c_{24}	1.35±0.81	1.42±0.79	1.33±0.67	0.13	0.88
d_4	5.58±2.13	5.34±2.34	6.06±2.12	1.43	0.24
d_8	3.56±1.81	3.65±1.86	3.64±1.42	0.05	0.95
d_{16}	2.65±1.37	2.93±1.34	2.36±1.05	2.52	0.08
d_{24}	2.59±1.35	2.70±1.37	2.45±1.07	0.40	0.67
e_4	5.63±2.49	5.32±2.53	6.40±2.35	2.66	0.07
e_8	3.02±1.80	2.97±1.74	3.22±1.47	0.34	0.71
e_{16}	1.70±1.12	1.84±1.11	1.51±0.81	1.26	0.29
e_{24}	1.41±0.87	1.37±0.86	1.25±0.58	0.65	0.52
Mean bone thickness	3.81± 2.41	3.85± 2.39	3.82± 2.40	0.09	0.91

In the present study, the thickness of bone was determined at 20 points in 161 subjects. Table 1 presents the characteristics of bone at the above-mentioned points.

According to above table,the 1-way analysis of variance showed no significant differences between three different facial height groups at none of the 20 points. Also there were no statistically significant differences in mean bone thickness of all 20 points due to facial height.

Discussion

Use of mini-screws has ever-increasingly been advocated in orthodontics in recent years. This type of anchorage has many advantages over conventional anchorage, including an increase in the range of orthodontic movements without application of force on other teeth, an easy scheme to produce force, a decrease in the need for patient compliance and ease of placement and removal.[5]

Various factors influence the success of mini-implants, including anatomic factors, mini-implant design, oral hygiene, the technique used and the force applied; based on the results of various studies, bone thickness has a specific effect on the success of mini-implants.[6]

In the present study, Cone beam CT technique was used to evaluate the thickness of palatal bone. Cone beam CT provides high-resolution images with low patient dose compared to the CT technique. Cone beam CT provides images of anatomic structures without any superimposition and these images can be used for secondary reconstructions (sagittal, coronal and para-coronal in 3-dimensional images) [14-18]. In the present study, bone thickness was determined at 20 points in the palate and the relationship between bone thickness at these points with the facial height was evaluated; at none of the points definite statistical relationship was established. There are only a limited number of studies available on the relationship between bone thickness and the facial height and none of these studies has evaluated the relationship between the facial height and bone thickness of maxillary palatal bone.

Ozdemir et al[13] evaluated the mandibular buccal, maxillary buccal and the alveolar bone of maxillary palate and reported that in all the areas measured in low angle cases cortical bone thickness was clearly more than that in high angle cases. Inconsistecy among the outcomes of these two studies may be as a result of measurring different structures at different anatomical sites. Tsunori et al [19]and Masumoto et al[20] carried out studies on Asian cadavers and reported a relationship

between facial type and the thickness of mandibular cortical bone. They carried out measurements only in the mandible. Masumoto et al [20]measured 10 points in the mandible and showed that the thickness of cortical bone at some of these points have a relationship with the facial type rather than all the points.

The discrepancies between the results of different studies might be attributed to factors such as differences in racial traits, evaluations on live subjects or on dry skulls and differences in measurement points and structures.

Conclusion

In the present study we did not find any relationship between palatal bone thickness and facial height. As we have done our study with limited sample size and in a iranian population Further studies with larger sample size are necessary to evaluate the relationship between the thickness of bone and facial height.

References

[1] Bernhart T, Freudenthaler J, Dortbudak O, Bantleon HP, Watzek G. Short epithetic implants for orthodontic anchorage in the paramedian region of the palate. Clin Oral Implants Res 2001; 12: 624-31.

[2] Melsen B. Palatal growth studied on human autopsy material. Am J Orthod 1975; 68: 42-54.

[3] Revelo B, Fishman LS. Maturational evaluation of ossification of the midpalatal suture. Am J Orthod Dentofacial Orthop 1994; 105: 288-92.

[4] Schlegel KA, Kinner F, Schlegel KD. The anatomic basis for palatal implants in orthodontics. Int J Adult Orthod Orthognath Surg 2002; 17: 133-9.

[5] Wehrbein H, Merz BR, Diedrich P, Glatzmaier J. The use of palatal implants for orthodontic anchorage. Design and clinical application of the Orthosystem. Clin Oral Implants Res 1996; 7: 410-6.

[6] Kang S, Lee SJ, Ahn SJ, Heo MS, Kim TW. Bone thickness of the palate for orthodontic mini-implant anchorage in adults. Am J Orthod Dentofacial Orthop 2007; 131(Suppl): S74-81.

[7] Gracco A, Lombardo L, Cozzani M, Siciliani G. Quantitative conebeam computed tomography evaluation of palatal bone thickness for orthodontic miniscrew placement. Am J Orthod Dentofacial Orthop 2008; 134: 361-9.

[8] Gracco A, Lombardo L, Cozzani M, Siciliani G. Quantitative evaluation with CBCT of palatal bone thickness in growing patients. Prog Orthod 2006; 7: 164-74.

[9] Tosun T, Keles A, Erverdi N. Method for the placement of palatal implants. Int J Oral Maxillofac Implants 2002; 17: 95-100.

[10] Arun T, Isik F, Sayinsu K. Vertical Growth Changes After Adenoidectomy. The Angle Orthodontist 2003; 73(2): 146-150.

[11] Tsunori M, Mashita M, Kasai K. Relationship between facial types and tooth and bone characteristics of the mandible obtained by CT scanning. The Angle Orthodontist 1998; 68(6): 557-562.

[12] Moon CH, Park HK, Nam JS, Im JS, Baek SH. Relationship between vertical skeletal pattern and success rate of orthodontic mini-implants. American Journal of Orthodontics and Dentofacial Orthopedics 2010; 138(1): 51-57.

[13] Ozdemir F, Tozlu M, Germec-Cakan D. Cortical bone thickness of the alveolar process measured with cone-beam computed tomography in patients with different facial types. American Journal of Orthodontics and Dentofacial Orthopedics 2013; 143(2): 190-6.

[14] Mah J, Hatcher D. Current status and future needs in craniofacial imaging. *Orthod Craniofac* Res 2003; 6 Suppl 1: 10–16.

[15] Mah JK, Danforth RA, Bumann A, Hatcher D. Radiation absorbed in maxillofacial imaging with a new dental computed tomography device. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2003; 96: 508–513.

[16] Ludlow JB, Davies-Ludlow LE, Brooks SL. Dosimetry of two extraoral direct digital imaging devices: NewTom cone beam CT and Orthophos Plus DS panoramic unit. Dentomaxillofac Radiol 2003; 32: 229–234.

[17] Song JE, Um YJ, Kim CS, Choi SH, Cho KS, Kim CK. Thickness of posterior palatal masticatory mucosa: the use of computerized tomography. J Periodontol 2008; 79: 406-12.

[18] Marquezan M, Nojima LI, Freitas AO, Baratieri C, Alves Junior M, Nojima M. Tomographic mapping of the hard palate and overlying mucosa. Braz Oral Res 2012; 26(1): 36-42.

[19] Tsunori M, Mashita M, Kasai K. Relationship between facial types and tooth and bone characteristics of the mandible obtained by CT scanning. Angle Orthod 1998; 68: 557-62.

[20] Masumoto T, Hayashi I, Kawamura A, Tanaka K, Kasai K. Relationships among facial type, buccolingual molar inclination, and cortical bone thickness of the mandible. Eur J Orthod 2001; 23: 15-23.