CHAPTER 3

Materials and methods

This retrospective study was approved by the Human Experimentation Committee, Faculty of Dentistry, Chiang Mai University (No.39/2559).

Subjects and image acquisition

The subjects were thirty adult Thai orthodontic patients (8 males and 22 females; aged 19.86±3.56 years; range 15.00-29.08 years), who required pretreatment CBCT images (Table 3.1). All subjects had met the following inclusion criteria: 1) age from 15.00 to 30.00years; 2) full eruption of permanent dentition (except for the third molars); 3) no history of previous orthodontic treatment; 4) no evidence of craniofacial malformations; 5) no history of bone-altering medications or diseases; 6) absence of torus palatinus; 7) a Class I malocclusion with Class I sagittal skeletal relationship (ANB angle = 2±2 deg.). The subjects who had malalignment of tooth in the palatal area had been excluded.

Table 3.1 Age (years) distribution by gender and number of subjects (N)

Gender	N	Minimum	Maximum	Mean	SD
Female	22	15.00	29.08	20.29	3.49
Male	8	15.00	24.16	18.69	3.71
Total	30	15.00	29.08	19.86	3.56

Cephalometric tracings were made on lateral cephalometric radiographs of the subjects. The following landmarks were marked on the tracings: S (sella); N (nasion); Go (gonion); Gn (gnathion); ANS (anterior nasal spine); PNS (posterior nasal spine); A (subspinale); B (supramenton); M (menton); and Ar (articulare).

The subjects were categorized into two groups according to the vertical skeletal configuration. The vertical skeletal configuration was determined according to six cephalometric measurements: 1) SN-GoGn angle; 2) SN-PP angle; 3) PP-GoGn angle; 4) gonial angle; 5) ratio of upper to lower face height; 6) ratio of posterior to anterior face height (15).

1. SN-GoGn: angle measuring the inclination of the mandibular plane in relation to the anterior cranial base. An angle that is greater than the Thai norm±SD indicates open vertical skeletal configuration. (Thai norm = 29.0±4.0 deg.)

2. SN-PP: angle formed by the intersection of the sella-nasion line and the palatal plane (ANS and PNS). This established the degree of inclination of the maxilla in relation to the anterior cranial base. An angle that is less than the Thai norm±SD indicates open vertical skeletal configuration. (Thai norm = 9.4±3.2 deg.)

3. PP-GoGn: angle formed by the intersection of the palatal plane (ANS and PNS) and the mandibular plane. This established the degree of inclination of the mandible in relation to the maxilla. An angle that is greater than the Thai norm±SD indicates open vertical skeletal configuration. (Thai norm = 20.3±4.9 deg.)

4. ArGo-GoMe (gonial angle): angle formed by the posterior border of the ramus of the mandible and the mandibular plane. An angle that is greater than the Thai norm±SD indicates open vertical skeletal configuration. (Thai norm = 120.0±6.0 deg.)

5. UAFH/LAFH ratio: ratio obtained by the proportion between the upper anterior face height and the lower anterior face height.

Upper anterior face height (UAFH): linear measurement of N-ANS

Lower anterior face height (LAFH): linear measurement of ANS-Me

A ratio that is less than the Thai norm indicates open vertical skeletal configuration. (Thai norm = 45:55 or 82 percent)

6. PFH/AFH ratio: ratio obtained by the proportion between the posterior face height and the anterior face height.

Posterior face height (PFH): linear measurement of S-Go

Anterior face height (AFH): linear measurement of N-Me

A ratio that is less than the Thai norm±SD indicates open vertical skeletal configuration. (Thai norm = 67.0±5.0 percent)

All cephalometric radiographs were traced and measured twice by the same examiner after a four-week interval. The open vertical skeletal configuration was chosen when the configuration was confirmed by three or more cephalometric measurements. The normal vertical skeletal configuration was chosen when four or more cephalometric measurements indicated normal vertical skeletal configuration.

The subjects were divided into two groups. Group 1 (N = 15), the Class I normal bite group, represented patients exhibiting normal overbite (overbite = 0-2.0 mm) and a normal vertical skeletal configuration (5 males and 10 females; aged 20.50±3.80 years; range 15.00-29.08 years), and Group 2 (N = 15), the Class I open bite group, represented patients exhibiting anterior open bite (overbite < 0 mm) and an open vertical skeletal configuration (3 males and 12 females; aged 19.10±3.20 years; range 15.0-25.58 years). General information on the subjects is shown in Table 3.2. The cephalometric measurements in each group are shown in Table 3.3.

Thirty CBCT images were produced using a ProMax 3D (Planmeca OY, Helsinki, Finland) machine at 84 kVp, 10 mA, an 8 cm×8 cm field of view, and a voxel size of 0.16 mm. Each patient was positioned with the occlusal plane horizontal.

Table 3.2 General information on subjects

General	Class I normal bite	Class I open bite
Sex	Males 5	Males 3
	Females 10	Females 12
Age (Yrs)	20.50±3.80	19.10±3.20

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Table 3.3 Cephalometric measurements in each group

Cephalometric parameters	Norm		Class I normal bite		Class I open bite	
	Mean	SD.	Mean	SD.	Mean	SD.
SN-GoGn angle	29.00	4.00	31.20	5.64	34.70	10.01
SN-PP angle	9.40	3.20	8.20	3.91	7.63	4.06
PP-GoGn angle	20.30	4.90	23.26	5.70	29.66	4.97
Gonial angle (ArGoGn)	120.00	6.00	121.33	4.60	125.13	6.01
UAFH/LAFH	82.00	-	81.94	5.87	75.19	4.61
PFH/AFH	67.00	5.00	70.20	5.31	62.39	3.93
ANB	2.00	2.00	2.30	0.99	2.76	1.68

Measurement of palatal bone thickness

Using the Romexis viewer program (Figure 3.1), a line joining the middle of the distal bony margin of the incisive foramen and the posterior nasal spine (PNS) was oriented to the midsagittal plane (Figures 3.2 and 3.3). In the midsagittal view, the horizontal reference plane was oriented to pass through the middle of those distal bony margins of the incisive foramen and PNS (29, 37, 69,72) (Figure 3.4).
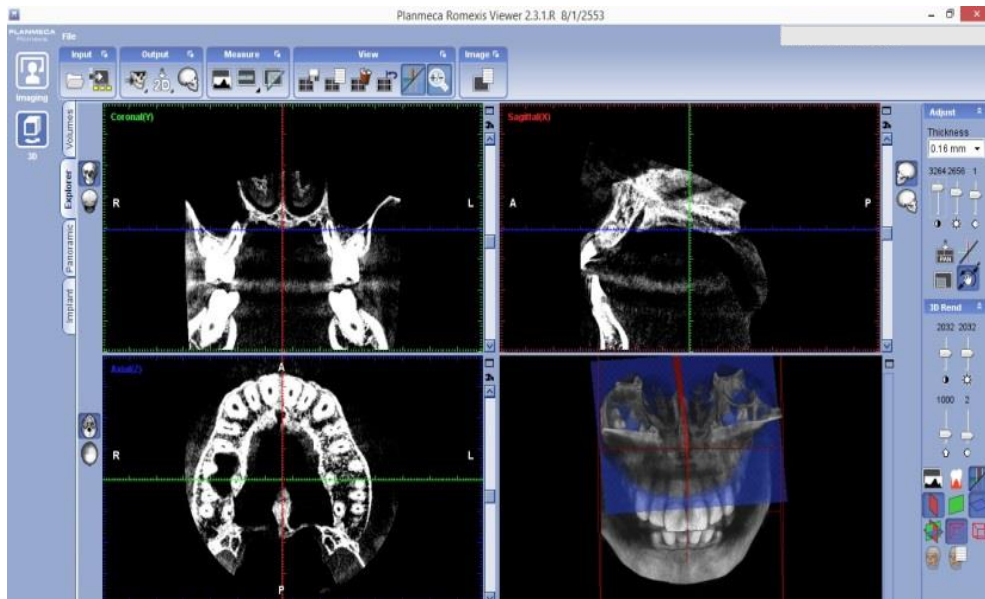
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Figure 3.1 CBCT images were oriented, using the Romexis viewer program.
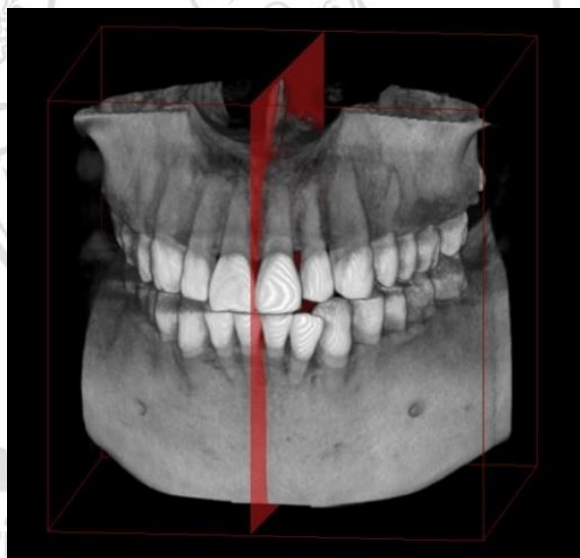

Figure 3.2 The three-dimensionalimage shows that a line joining the middle of the distal bony margin of the incisive foramen and PNS isoriented to the midsagittal plane.
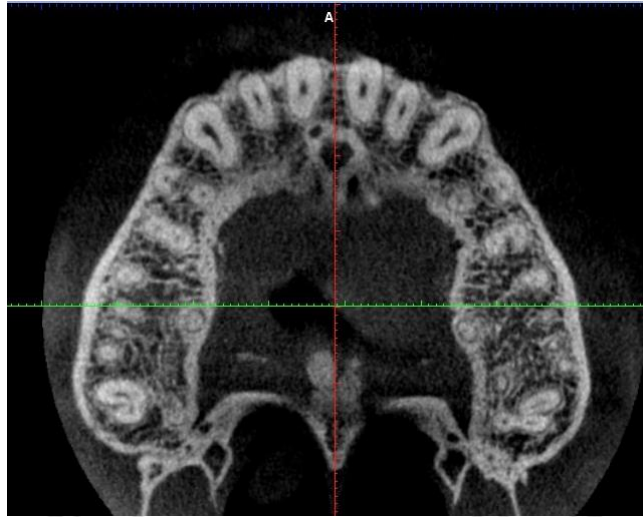
Figure 3.3 In the axial view, a line joining the middle of the distal bony margin of the incisive foramen and PNS is oriented to the midsagittal plane.
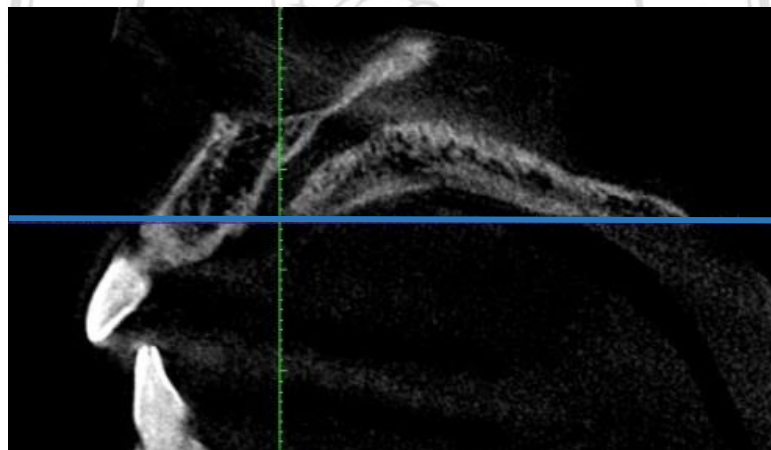

Figure 3.4 In the midsagittal view, the horizontal reference plane is oriented to pass through the middle of those distal bony margins of the incisive foramen and PNS.

In the sagittal view, the total palatal bone and cortical bone thickness were measured at 3.0-mm intervals (3, 6, 9, 12, 15, 18, 21, 24 mm) posteriorly from the middle of the distal bony margin of the incisive foramen to PNS (Figure 3.5). In each frontal view, the total palatal bone and cortical bone thickness were measured at 3.0-mm intervals (0, 3, 6, 9, 12 mm) laterally from the midsagittal reference plane (inclusive) on both right and left sides (Figure 3.6), producing, eventually, a grid pattern of measurements (Figure3.7). The total palatal bone thickness was measured

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perpendicular to the horizontal reference plane from the outer border of the palatal cortical bone to the outer border of the cortical bone of the nasal floor, maxillary sinus floor, or incisive canal floor. The palatal cortical bone thickness was measured perpendicular to the horizontal reference plane from the outer to inner border of the palatal cortical bone (Figure 3.8).

Each measurement site was named according to the anteroposterior (AP) intervals and the mediolateral intervals on both right and left sides. For example, the measurement site marked "x" in Figure 3.7 would be named Left AP6/ML3.
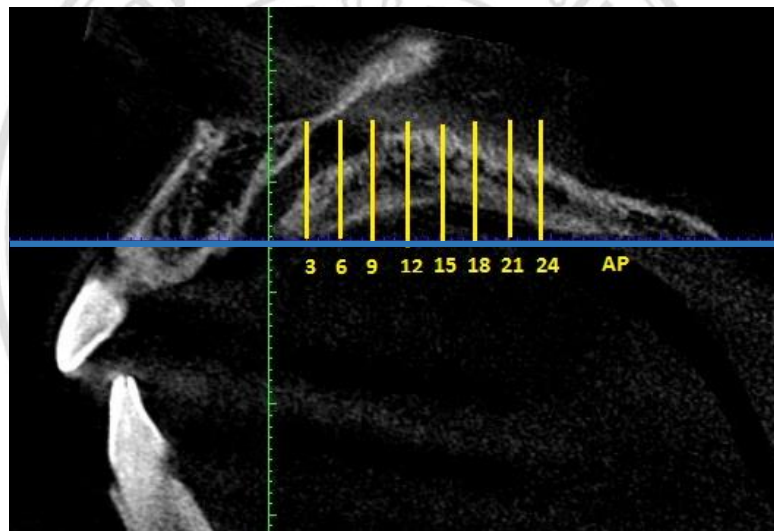

Figure 3.5 In each sagittal view, the total palatal bone and cortical bone thicknesses were measured perpendicular to the horizontal reference plane at 3.0-mm intervals posteriorly from the middle of the distal bony margin of the incisive foramen to PNS.
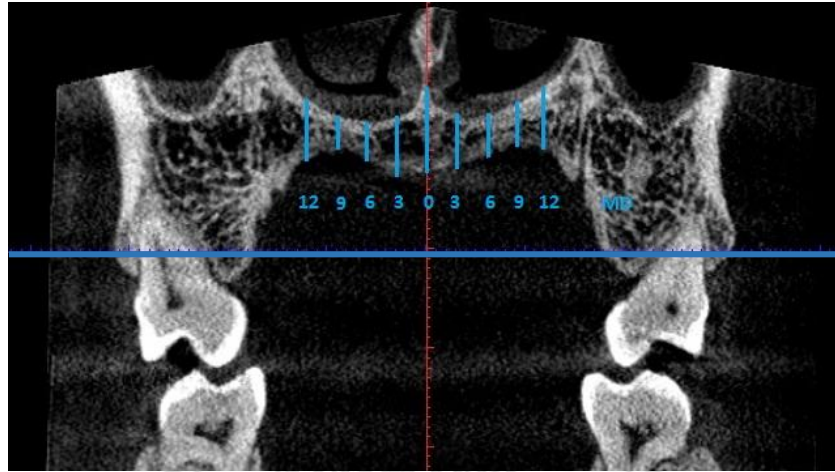
Figure 3.6 In each frontal view, the total palatal bone and cortical bone thicknesseswere measured at 3.0-mm interval slaterally from the midsagittal reference plane on both right and left sides.
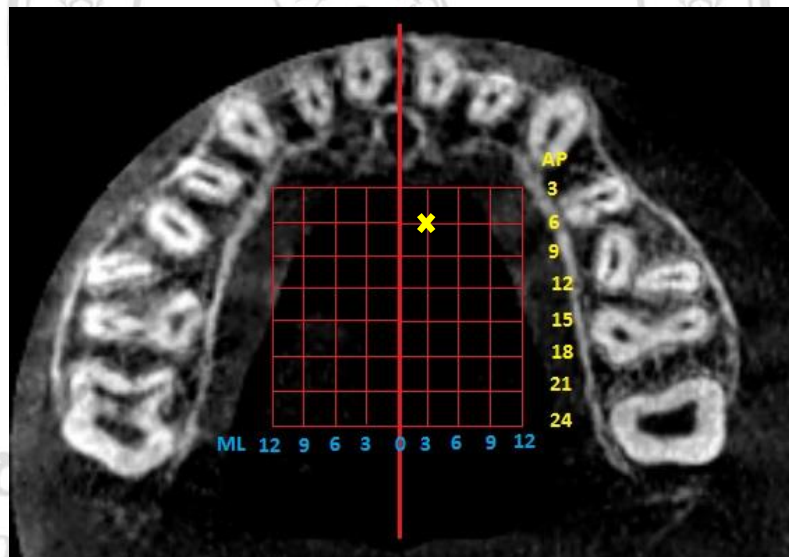

Figure 3.7 Measurement sites in a grid pattern at 3.0-mm anteroposterior intervals posteriorly from the middle of the distal bony margin of the incisive foramen (AP 3, 6, 9, 12, 15, 18, 21, 24 mm-sections), and at 3.0-mm mediolateral intervals laterally from the midsagittal plane on both right and left sides (ML 0, 3, 6, 9, and 12 mm-sections). The measurement site marked "x" was named Left AP6/ML3.
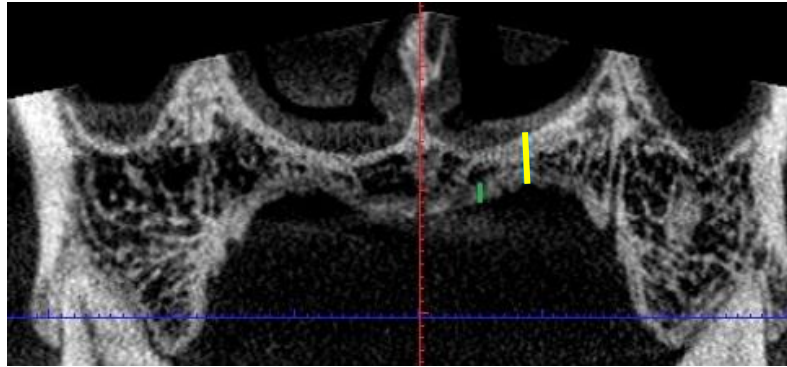
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Figure 3.8 Paracoronal image showing measurement of the total palatal bone thickness (yellow line) and the palatal cortical bone thickness (green line)

To test the intra-examiner reliability, ten randomly-selected CBCT images were re-measured by the same examiner after a four-week interval. The intra-class correlation coefficient (ICC) was used to assess the reliability of the first and second measurements. In addition, ten randomly-selected CBCT images were re-measured by the oral and maxillofacial radiologist. The ICC was used to test the inter-examiner reliability.

Instruments

- ProMax 3D CBCT unit
- Software Romexis Viewer program

Statistical analysis

Data were analyzed using SPSS 17.0 (SPSS Inc., Chicago, Ill., USA). All data were tested for normality with the Shapiro-Wilk test.

Means and standard deviations of the palatal bone thickness in the Class I normal bite and Class I open bite groups were measured and compared using the Independent-T-test. Results were considered statistically significant at $P<0.05$.

Means and standard deviations of the palatal cortical bone thickness in the Class I normal bite and Class I open bite groups were measured and compared using the Independent-T-test. Results were considered statistically significant at $P<0.05$.

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