

# Comparison of cephalometric measurements and cone-beam computed tomography-based measurements of palatal bone thickness

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**Introduction:** The purpose of this study was to determine the relationships between cephalometric measurements and cone-beam computed tomography-based measurements of the palatal bone thickness. **Methods:** Thirty sets of cone-beam computed tomography images and lateral cephalograms were used. Palatal bone thicknesses were measured anteroposteriorly from between the first and second premolars to between the first and second molars using both imaging methods, and also laterally from 1.5 mm off-center to 10 mm off-center in the cone-beam computed tomography images. Repeated-measures analysis of variance was used to examine the differences between the measurements. **Results:** Bland-Altman plots showed that the 95% limits of agreement were smallest at 5 mm off-center ( $-0.2 \pm 1.7$  mm). The 5-mm off-center measurements were the only ones for which there were no statistically significant differences compared with the cephalometric measurements in all anteroposterior areas. The measurements at 1.5 mm off-center were significantly thicker than the cephalometric measurements only from the area between the second premolar and the first molar to the area between the first and second molars. **Conclusions:** Among the areas measured, the bone at 5 mm off-center is most likely to be depicted in cephalograms as palatal bone contours. (Am J Orthod Dentofacial Orthop 2014;145:165-72)

The palate is a preferred area for orthodontic mini-implant placement because there is little danger of damaging anatomic structures other than the incisive foramen.<sup>1,2</sup> Also, there is a relatively large bone mass in the median and flanking regions of the palate with dense soft tissues on the surface of the hard palate, thus facilitating the formation of compact connective tissues around the cervical part of the implant.<sup>3,4</sup>

The most appropriate length for a mini-implant should be determined from measurements of the palatal bone thickness to ensure that the maximum thickness of palatal bone is used without penetrating the palate.

Although cone-beam computed tomography (CBCT) can be used to measure palatal bone thickness, Jung et al<sup>5</sup> and Winsauer et al<sup>6</sup> suggested that CBCT should be used only in rare cases of borderline palatal bone thickness.

A cephalogram can be used to measure palatal bone thickness, but care must be taken because of the magnification, which is typically 110%.<sup>7,8</sup> Because a cephalogram is a 2-dimensional view of a 3-dimensional object with a perspective projection, the magnifications of the right and left structures differ, resulting in an unequal overlap of these structures. The location of an object between the x-ray source and the film determines the magnification of the image, with structures closer to the x-ray source appearing larger. The distance between the source and the subject's midsagittal plane is typically 1500 mm, and the distance between the subject's midsagittal plane and the detector is 150 mm, with the central ray passing through the center of the mechanical portion. The half of the palatal bone that is closer to the source is projected on the film as if it were positioned more inferiorly, and so it appears larger than the half on the contralateral side. To illustrate the typical magnification in the cephalogram of palatal bone thickness at 5 mm off-center, consider the following assumptions (Fig 1): the palatal

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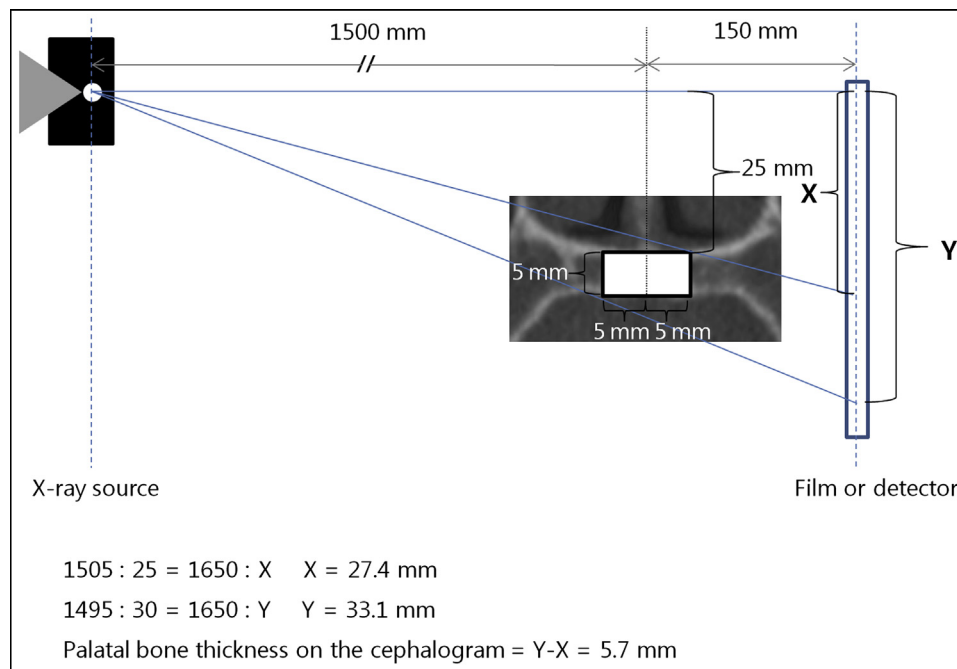
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**Fig 1.** Schematic of the magnification of palatal bone at 5 mm off-center. A bone thickness of 5 mm at the 5-mm off-center area will be projected onto the film as a 5.7-mm bone thickness.

**Table I.** Sample characteristics

	Males (n = 15)		Females (n = 15)	
	Mean	SD	Mean	SD
Age (y)	19.6	3.4	19.7	3.8
ANB (°)	1.2	5.1	3.1	3.7
FMA (°)	26.5	4.7	28.0	4.1
ICW (mm)	36.0	2.6	35.7	2.1
IMW (mm)	38.7	3.2	38.2	3.3

ICW, Inter canine width; IMW, intermolar width, the distance between the maxillary first molars measured at the intersection of the lingual groove and the gingival margin.

bone thickness at 5 mm off-center is 5 mm, and the vertical distance from the central ray to the superior side of the palatal bone is 25 mm. According to the calculation of magnification illustrated in Figure 1, a 5-mm thickness of palatal bone at 5 mm off-center will be projected onto the film as a thickness of 5.7 mm, which is a magnification of 114%. Jung et al<sup>9</sup> reported that the vertical dimensions on lateral cephalometry reflect the minimum thickness of bone and not the maximum thickness in the median plane. In that study, the nasal floors and palates of dry skulls were covered with tinfoil before the radiographs were obtained. In this condition, the bony palate will probably appear thinner in the cephalogram because its apparent thickness will be determined by the oblique

x-rays passing through the tinfoil on the nasal floor closer to the x-ray source and the tinfoil on the palatal side closer to the film. Covering the nasal floor and palate with tinfoil from the center to 5 mm off-center will result in 106% magnification instead of 114% when the same conditions shown in Figure 1 are assumed.

In several studies, the authors, using CBCT or computed tomography, found that the palatal bone thickness tends to decrease laterally or posteriorly.<sup>1,2,10-13</sup> Wehrbein et al<sup>14</sup> reported that the thickness of the anterior and median hard palate was 2 mm thicker than that shown in lateral cephalograms. Cephalograms might not depict the maximum thickness of the median palate, but no previous study has investigated which part of the palate in the transverse aspect is depicted on the cephalogram.<sup>9,14</sup>

The purpose of our study was to test the null hypothesis that there is no relationship between palatal bone thickness values in various transverse areas measured cephalometrically and with CBCT.

## MATERIAL AND METHODS

This study was approved by the local ethics committee of School of Dentistry, Chosun University, Gwangju, Korea (CDMDIRB 1218-86). Thirty sets of CBCT images and cephalograms (for 15 male and 15 female subjects) were selected from among the CBCT and cephalogram

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