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ORIGINAL ARTICLE

Palatal bone thickness and associated factors in adult miniscrew placements: A cone-beam computed tomography study

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Abstract Palatal bone thickness measurements obtained by cone-beam computed tomography (CBCT) in 30 men and 28 women were evaluated for associated factors. Palatal bone thickness was measured at 20 locations unilateral to the midpalatal suture and posterior to the incisive foramen. Tongue position, presence of posterior crossbite, and palatal morphology were recorded. Lateral cephalograms acquired from CBCT data were used to calculate Frankfort-mandibular plane angles (FMA). At almost all sites, bone thickness was greater in males than in females, but the difference was statistically significant at only seven sites. Bone thickness showed no associations with tongue position, palatal morphology, or presence of posterior crossbite. In women, FMA significantly correlated with bone thickness at 12 locations. In conclusion, palatal bone thickness is unassociated with tongue position, posterior crossbite, or palatal morphology. In hyperdivergent women, however, available bone may be smaller than normal in the middle and posterior palatal areas; in such cases, a shorter than normal miniscrew may be needed to avoid penetrating the nasal cavity.

Conflicts of interest: All authors declare no conflicts of interests.

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Introduction

The orthodontic miniscrew is now the most frequently used temporary anchorage device because of its many advantages, including its simple surgical placement and removal and its low cost. However, if primary stability is not achieved upon insertion, the miniscrew may loosen during orthodontic treatment [1].

The anterior midpalatal and paramedian palate regions are potential sites of miniscrew placement [2,3] because these areas are devoid of major blood vessels and nerves. Therefore, these regions are relatively safe for orthodontic treatments requiring miniscrew placement [3]. However, caution is needed to avoid nearby anatomical structures such as the nasal cavity above the palate and the incisive canal in the anterior palate. Selecting an excessively long miniscrew raises the risk of perforating the nasal cavity and related complications [4,5]. If the selected miniscrew is too short, however, the insertion depth into the bony structure may be insufficient to ensure good primary stability. Therefore, clinicians require sufficient topographical knowledge of the midpalate and paramedian palate regions to perform this procedure efficiently.

Recently developed cone-beam computed tomography (CBCT) technology now provides highly accurate and detailed information for a broad spectrum of clinical and research applications [6,7]. Since the stability of orthodontic miniscrews depends mainly on mechanical retention [8], researchers have studied methods of accurately assessing bone thickness [9—11], volume, and quality [12] to provide guidelines for selecting appropriate miniscrew insertion sites.

Craniofacial and dentoalveolar development is dependent on interacting genetic and environmental factors over time [13]. For example, one environmental factor that can affect morphological development of craniofacial features is respiration mode [14]. Many studies suggest that respiratory function affects maxillofacial growth and that mouth breathing is associated with a vertical facial profile [15]. Morphologic traits associated with respiratory obstruction and mouth breathing include an excessive anterior facial height, a steep mandibular plane angle, a low tongue posture, a narrow palatal vault, and a posterior crossbite [13].

Although the midpalatal and paramedian palate regions tend to have relatively good bone quality [6], miniscrew failures may still occur in these areas [5]. Because bone thickness is a key factor in achieving primary stability [3], identifying the factors associated with palatal bone thickness can help clinicians identify cases of inadequate bone thickness so that orthodontic anchorage plans can be modified accordingly.

This study identified factors associated with palatal bone thickness measured using CBCT. By using these data to identify appropriate implantation sites with optimal bone thickness, clinicians can ensure primary stability in miniscrew implants.

Materials and methods

This study analyzed CBCT scans from 58 patients (30 men: mean age, 25.79 years; range, 23.9—27.7 years and 28 women: mean age, 27.66 years; range, 25.0—30.3 years) treated at the Department of Orthodontics, Kaohsiung Medical University Hospital (KMUH), Kaohsiung, Taiwan. Exclusion criteria were an impacted tooth in the region of interest (ROI) in the anterior midpalatal and paramedian palate, two or more missing posterior teeth, and history of maxillofacial trauma. The study protocol was approved by the University Hospital Ethnical Committee (KMUH-IRB-20140111).

The settings for the i-CAT cone-beam three-dimensional (3D) imaging system (Imaging Sciences International, Hatfield, PA, USA) used for the CBCT scans were 120 kVp; 47 mA; exposure time, 40 seconds; resolution, 0.25 mm voxel size; and field of view, 20 cm × 25 cm. All scans were performed with the head of the patient in a natural position and with the patient biting in centric occlusion. Data were stored in Digital Imaging and Communications in Medicine (DICOM) 3D format, and a medical image analyzing system (iCAT vision software, version 1.6.2.0; Imaging Sciences International, Hatfield, PA, USA) was used for image reconstruction. Measurements were made on sagittal reconstructions.

All reconstructed images were oriented in the standardized position before performing the measurements. After locating the incisive foramen and posterior nasal spine (PNS) in horizontal view, a reference line was constructed across the midpalatal suture (Fig. 1A). In sagittal view, a midsagittal reference line was then projected through the distal margin of the incisive foramen and PNS (Fig. 1B); all subsequent measurements were made perpendicular to this reference line.

Measurements taken 0 mm, 2 mm, 4 mm, and 6 mm lateral to the midpalatal suture were designated D0, D2, D4, and D6, respectively. Measurements taken 6 mm,

Figure 1. (A) Horizontal view: incisive foramen can be clearly identified. (B) Sagittal view and midsagittal reference line passing through incisive foramen and posterior nasal spine (PNS).