Anatomic assessment of the mandibular buccal shelf for miniscrew insertion in white patients

Tarek Elshebiny, Juan Martin Palomo, and Sebastian Baumgaertel
Cleveland, Ohio

Introduction: Cortical bone thickness, bone width, insertion depth, and proximity to nerves are important factors when planning and placing orthodontic miniscrews. The objective of this study was to anatomically assess the mandibular buccal shelf in a white patient population as the insertion site for orthodontic miniscrews by investigating these 4 variables. **Methods:** Measurements were made on cone-beam computed tomography scans of 30 white patients (18 girls, 12 boys; mean age, 14.5 ± 2 years). All measurements were taken adjacent to the distobuccal cusp of the first molar, and the mesiobuccal and distobuccal cusps of the second molar. Additionally, bone depth was measured at 2 height levels, 4 and 8 mm from the cementoenamel junction. Stereolithographic models of patients were superimposed on the cone-beam computed tomography volumes to virtually create an outline of the soft tissue on the cone-beam computed tomography image to allow identification of the purchase point height (mucogingival junction). The inferior alveolar nerve was digitally traced. Miniscrews (1.6 × 10 mm) were virtually placed at the buccal shelf, and their insertion depths and relationships to the nerve were assessed. Analysis of variance with post hoc analysis was used for data analysis. **Results:** Insertion sites and measurement levels had significant impacts on both cortical bone thickness and bone width. Cortical bone thickness was typically greatest at the distobuccal cusp of the second molar. Bone width was also greatest at the distobuccal cusp of the second molar 8 mm from the cementoenamel junction. The greatest insertion depth was found again at the distobuccal cusp to the second molar, whereas the miniscrews had the greatest proximity to the nerve at this site also. **Conclusions:** The distobuccal cusp level of the mandibular second molar is the most appropriate site for miniscrew insertion at the buccal shelf in white patients. (Am J Orthod Dentofacial Orthop 2018;153:505-11)

One of the most important factors when placing orthodontic miniscrews is the presence of sufficient bone at the insertion site.[1] Miniscrews are placed in many anatomic sites depending on the biomechanics used.[2-4] The most popular anatomic sites appear to be the palate, lingual aspect of the maxillary alveolar process, retromolar area, and maxillary and mandibular buccal alveolar processes.[2-6] Several studies have used cone-beam computed tomography (CBCT) to assess cortical bone thickness and overall bone depth to determine the most favorable anatomic insertion sites and to evaluate the structures at risk at various sites.[1,7]

From the Department of Orthodontics, School of Dental Medicine, Case Western Reserve University, Cleveland, Ohio.
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Address correspondence to: Sebastian Baumgaertel, Department of Orthodontics, School of Dental Medicine, Case Western Reserve University, 10900 Euclid Ave, Cleveland, OH 44106; e-mail, sxb155@case.edu.
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Recently, the mandibular buccal shelf has been used as an insertion site for orthodontic miniscrews. Indications for the buccal shelf as the insertion site are plentiful, but this site seems to be most useful for the correction of Class III malocclusions.[8-10] However, despite reports of numerous treated patients, there was inconsistency in selecting the exact placement site in the mandibular buccal shelf; recommendations included adjacent to the first molar, between the first and second molars, and adjacent to the second molar.[10,11] This wide range of recommendations may be due to strong local anatomic variations at the buccal shelf or the lack of studies that investigated the local anatomy. The purposes of this study were to remedy this lack of anatomic information by evaluating cortical bone thickness and bone width of the mandibular buccal shelf at different potential insertion sites and to assess the relationship between the miniscrews and the inferior alveolar nerve as the only sensitive anatomic structure in this area.

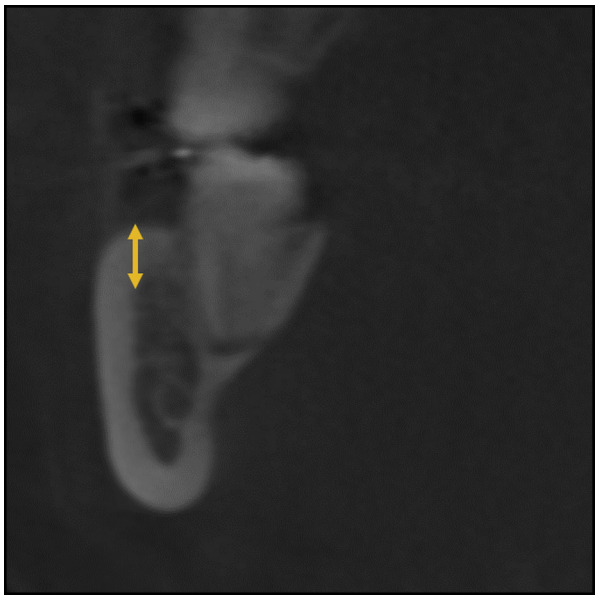

Fig 1. Coronal slice at the distal root of the second molar showing measurement of the cortical bone.

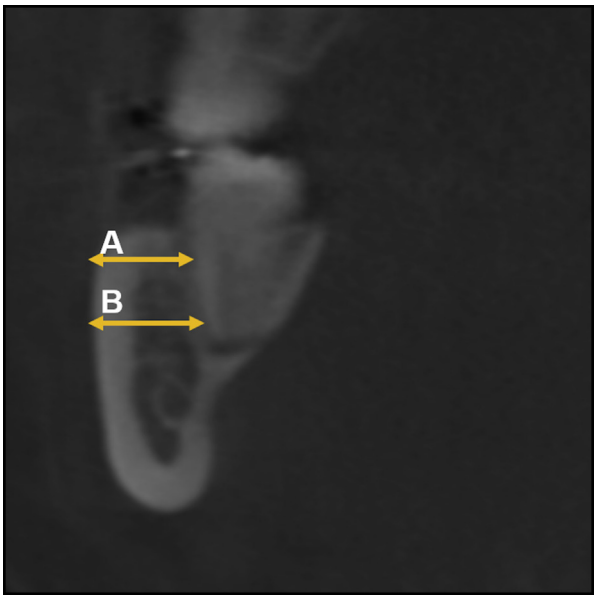

Fig 2. Coronal slice at the distal root of the second molar showing measurement of the overall bone width at: *A*, 4 mm from the CEJ and *B*, 8 mm from the CEJ.

MATERIAL AND METHODS

This study was approved by the Institutional Review Board of Case Western Reserve University in Cleveland, Ohio. The sample consisted of 30 CBCT scans of untreated orthodontic patients (18 girls, 12 boys; average age, 14.5 ± 2 years) from the Department of Orthodontics at Case Western Reserve University who had CBCT imaging prescribed as part of their initial records. No CBCT image was taken for research purposes only. Inclusion criteria consisted of white patients seeking orthodontic treatment and full permanent dentition with fully erupted mandibular second molars and no craniofacial pathology or developmental abnormality. All CBCT images were taken with a low-dose scanner, CB MercuRay (Hitachi Medical Systems of America, Twinsburg, Ohio), using 2 mA, 120 kV(p), resulting in a voxel size of 0.37 mm. All images were analyzed with Dolphin 3D (version 11.9; Dolphin Imaging and Management Solutions, Chatsworth, Calif).

After proper orientation, cortical bone thickness and buccal shelf bone width were surveyed at 3 sites on each side: buccal to the distobuccal cusp of the mandibular first molar (6D), and buccal to the mesiobuccal (7M) and distobuccal (7D) cusps of the mandibular second molar. Cortical bone thickness was defined as the dimension of the cortical bone measured from the midpoint of the osseous ledge buccal to the mandibular first and second molars (buccal shelf), parallel to the contour of the buccal root surfaces of the first or second molar (Fig 1).

Buccal shelf bone width was defined as the total amount of bone available in the buccolingual direction from the most buccal point of the alveolar bone to the root of the mandibular molars at 4 and 8 mm from the cementoenamel junction (CEJ), parallel to the occlusal plane. Again, measurements were taken at the same 3 sites: buccal to the distobuccal cusp of the mandibular first molar (6D4, 6D8), buccal to the mesiobuccal cusp of the mandibular second molar (7M4, 7M8), and buccal to the distobuccal cusp of the mandibular second molar (7D4, 7D8) (Fig 2).

The inferior alveolar nerve canal was digitally traced using a tool in the software (Fig 3). Stereolithographic models of the patients were superimposed on the CBCT volumes to virtually create an outline of the soft tissues (Fig 4). Miniscrews (1.6 mm diameter × 10 mm shank length) were then virtually placed at the designated sites. Based on the recommendations of Chang et al,[10] the insertion was initiated (purchase point) at the mucogingival junction as identified on the stereolithographic model. The insertion took place perpendicular to the occlusal plane and was considered complete with the screw head 5 mm above the level of the soft tissue (Fig 5). The insertion depth of the miniscrew and the relationship to the digitally traced inferior alveolar nerve were also assessed at the 3 sites (D6, M7, D7) (Fig 6).