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Mandibular posterior anatomic limit for molar distalization

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Introduction: The purpose of this study was to investigate the mandibular posterior anatomic limit for molar distalization. **Methods:** Three-dimensional computed tomography scans were obtained on 34 adults with a skeletal Class I normodivergent facial profile and a normal occlusion. Posterior available space was measured at the crown and root levels along the posterior occlusal line connecting the buccal cusps of the first and second molars on the axial slices. It was also measured at the occlusal level on the lateral cephalograms derived from the computed tomography scans. The measurements on the cephalograms were used to predict the actual posterior available space determined by computed tomography and to determine the presence of root contact with the inner lingual cortex by linear regression and discriminant analyses, respectively. **Results:** The posterior available space was significantly smaller at the root level than at the crown level. Root contact was observed in 35.3% of the 68 roots. The posterior available space measured on the lateral cephalograms resulted in a regression equation with a coefficient of determination of 0.261 to predict actual available space and correctly identified root contact in 66.2% of cases with a threshold value of 3.9 mm. **Conclusions:** The posterior anatomic limit appeared to be the lingual cortex of the mandibular body. Computed tomography scans are recommended for patients who require significant mandibular molar distalization. (Am J Orthod Dentofacial Orthop 2014;146:190-7)

Molar distalization is a nonextraction treatment modality used to correct Class II or Class III molar relationships[1,2] and to relieve crowding without adverse arch expansion, which can jeopardize both esthetics and stability.[3,4] Recently, its clinical significance has increased because of the introduction of temporary anchorage devices in orthodontic treatment; these enable predictable molar distalization with minimal patient compliance.[5,6] Regardless of the anchorage unit used for distalization, however, there is a posterior anatomic limit beyond which orthodontic tooth movement can barely be achieved. Although the maxillary arch has a clear posterior limit—the maxillary tuberosity—the limit for the mandibular arch is not yet clear.

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Previous studies regarding the retromolar region have focused on the posterior available space observed on panoramic radiographs or lateral cephalograms to calculate the posterior space discrepancy or to predict the prognosis of third molar eruption.[7-13] In most of these studies, the anterior border of the ramus was presumed to be the posterior limit of the mandibular arch, and the available space was measured along the occlusal plane.[7,8,11-13] However, these 2-dimensional radiographs have inherent sources of error, such as differential magnification and distortion, and also they are projected images that cannot represent the 3-dimensional (3D) morphology of the mandibular ramus.[14]

Another issue that has received little attention to date is the limitation to the alveolar bone housing for posterior teeth caused by the inner and outer lingual cortexes of the mandibular body. With regard to alveolar bone housing, it has been suggested that teeth should be moved within the boundaries of cortical bones[15] to form an "envelope of discrepancy," which describes mainly incisor movement in the sagittal plane and molar movement in the coronal plane.[16] However, little is known about the alveolar bone housing for the distalization of the mandibular molar, which might determine the posterior limit. This is possibly due to the lack of an appropriate diagnostic tool and the difficulty in anchorage preparation for mandibular molar distalization before the introduction of temporary anchorage devices to orthodontics.

Recently, 3D computed tomography (CT) has become widely used in dental practice, and it can provide accurate anatomic information, such as cortical bone thickness and interroot distance.[17,18]

The purposes of this study were to (1) determine the posterior anatomic limit by comparing the posterior available spaces measured at various levels of the mandibular second molar on axial slices of 3D CT, and (2) predict the posterior available space and the presence of root contact with the inner lingual cortex of the mandibular body using lateral cephalograms.

MATERIAL AND METHODS

This study was performed using a subset of CT images of patients from a previous study, selected on the basis of the following criteria: (1) adult skeletal Class I patients with normodivergent facial profile (age, >18 years; ANB, >0° and <4°; sella-nasion to mandibular plane angle, >30° and <38°), (2) no notable facial asymmetry, (3) normal overjet and overbite with Class I molar relationships, (4) crowding less than 2 mm in both arches, (5) healthy periodontal state with no noticeable alveolar bone loss, (6) no prostheses or missing teeth except third molars, (7) intact roots with no root anomalies such as idiopathic root resorption and severe dilacerations, and (8) no history of orthodontic treatment.[17] Thirty-four patients met the criteria and were included in this study. The characteristics of the patients are shown in Table I.

The 3D CT scans were obtained using Hispeed Advantage (GE Medical Systems, Milwaukee, Wis) with the following settings: 120 kV, 180 mA, slice thickness 3.0 mm, and pitch 1.5. The CT images were saved as DICOM files, each with a slice thickness of 1.0 mm. The DICOM data were reconstructed into 3D images using InVivoDental software (version 5.2; Anatomage, San Jose, Calif). The reconstructed 3D images were reoriented with the mandibular occlusal plane as a horizontal reference plane, connecting the midpoint of the mandibular incisor tip and both mesiobuccal cusps of the mandibular first molars to measure the posterior available space on the axial slices parallel to the mandibular occlusal plane. The coronal plane was constructed parallel to the transporionic line, while passing through the midpoint of the mandibular incisor tip, to generate CT-derived lateral cephalograms.[19] The midsagittal plane was established at right angles to the horizontal and frontal planes, while passing through the midpoint of the mandibular incisor tip (Fig 1).

The linear distances described below were measured using the InVivoDental software program. Measurements at crown (CR) and root level (RL) were made on the axial slices of CT images. The shortest distance between the mandibular second molar crown and the outer cortex of the ramus was measured parallel to the posterior occlusal line (POL) connecting the buccal cusps of the mandibular first and second molars at the occlusal level (CR_{OL}), and 2 mm from the occlusal level (CR_{2mm}) on the axial slices (Fig 2, *A*). The shortest distances between the mandibular second molar root and the inner/outer lingual cortex of the mandibular body were then measured parallel to the POL, at depths of 2, 4, 6, 8, and 10 mm ($RL_{in-2,4,6,8,10mm}$, $RL_{out-2,4,6,8,10mm}$) on the axial slices with the proximal cementoenamel junction as the reference level (Fig 2, *B* and *C*). The number and percentage of the roots that were in contact with the inner lingual cortex of the mandibular body were calculated at each measurement level. Lastly, the distance between the mandibular second molar and the anterior border of the ramus was measured parallel to the

Table I. Patient characteristics

Variable	*Mean*	*SD*	*Minimum*	*Maximum*
Age (y)	22.0	3.7	18	29
ANB (°)	2.9	0.8	1.4	3.9
SN-MP (°)	34.7	2.3	30.2	37.8

SN-MP, Sella-nasion to mandibular plane angle.

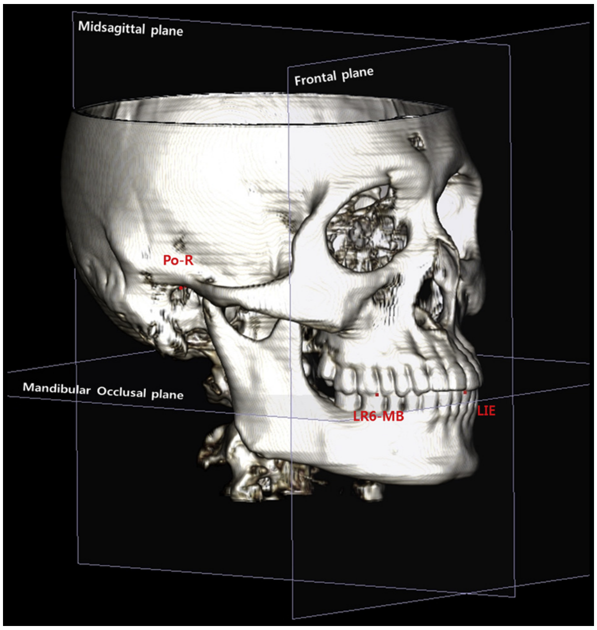

Fig 1. Reference planes and landmarks for reorientation of the reconstructed 3D images. *LIE*, Midpoint of the 2 mandibular central incisor tips; *LR6-MB*, mesiobuccal cusp of the mandibular first molar; *Po-R*, right porion.