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# Three-dimensional anatomic analysis of mandibular foramen with mandibular anatomic landmarks for inferior alveolar nerve block anesthesia

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**Objective.** We sought to standardize 3-dimensional anatomic positioning of the mandibular foramen (MnF) for inferior alveolar nerve block anesthesia.
**Study Design.** Three-dimensional mandibular computerized tomography (CT) images were reconstructed from data for 49 patients aged 8-16 years (growth group) and 59 patients aged 18-25 years (adult group). To measure MnF position, we defined 5,6 as the superior contact point between the mandibular first molar and second premolar and 5,6 MnFP as the point on the MnF plane intersecting 5,6 at a right angle. The MnF plane passed through the MnF and parallel to the occlusal plane.
**Results.** In the growth group, the distance from the MnF to the anterior ramus increased with age, as did distance from the gonion to MnF.
**Conclusions.** Measurements correlated significantly with age in the growth group. Needle insertion at an obtuse angle in the MnF plane from the contralateral first molar is appropriate for inferior alveolar nerve block anesthesia. (Oral Surg Oral Med Oral Pathol Oral Radiol 2013;115:e17-e23)

Inferior alveolar nerve block anesthesia (IANBA) is a necessary and fundamental local dental anesthetic procedure. Various complications have been reported during IANBA, such as needle breakage, blood vessel penetration, skin necrosis, diplopia, and nerve damage.[1-7]

Anesthetic failures can occur with IANBA for many possible reasons, including poor anesthetic technique and anatomical variation.[8] Various methods for IANBA have been reported,[9-11] but a more accurate IANBA injection does not necessarily increase the success rate.[12,13]

Three-dimensional anatomic positioning of the mandibular foramen (MnF), however, is important to the IANBA procedure. The position of the MnF should be located 3-dimensionally relative to anatomic structures in the oral cavity that can be used as reference landmarks. Moreover, the anatomic structures in the oral cavity that are selected as reference points should be easy and convenient to use regardless of the skill of the operator, and the error in the positioning of the MnF should be small. Using the height, angle, or length of clinical anatomic structures in the oral cavity as references to optimize the position of the MnF may help the efficacy of the IANBA procedure.

Thanks to the recent commercialization of computerized tomography (CT) and the development of computer software, studies on the anatomic structures of the human body have progressed. Therefore, the aim of the present study was to provide related standards for anatomic structures in the oral cavity that can be referred to during anesthetic injections so that the position of the MnF can be located easily and accurately for IANBA.

## MATERIALS AND METHODS

### Materials

The study used CT images of mandibles from patients who visited the Department of Oral and Maxillofacial Surgery, National Health Insurance Corporation Ilsan Hospital. The CT images of the patients were limited to those taken with an interval of <1 mm for a preoperative evaluation for surgical tooth extraction. The mandibular CT images were captured with the use of a Siemens Sensation 64 system (Siemens Medical Solutions, Malvern, PA, USA) with a pixel size of 0.4375, resolution of 512 × 512 pixels, field of view of 22.40, and 0.4-mm-thick slices. CT imaging of patients who had missing teeth or a pathologic lesion causing asymmetry and deviation of the mandible were excluded from the study. CT data were gathered from patients from aged 8-25 years; all patients had already undergone eruption of the mandibular anterior teeth and first molars, and patients 18 years of age were considered to have completed their physical growth. Forty-nine patients aged 8-16 years whose physical growth was ongoing were allocated to the growth group, and

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**Table I.** Description of the points, lines, and planes for the measurement of the mandibular foramen

| | *Name* | *Description* |
|---|---|---|
| Points | IM | Midpoint between the mesial incisal tips of the both mandibular central incisors |
| | 36MBC | Mesiobuccal cusp tip of the right mandibular first molar |
| | 46MBC | Mesiobuccal cusp tip of the left mandibular first molar |
| | 4,5 | The superior contact point between the mandibular first and second premolar |
| | 5,6 | The superior contact point between the mandibular first molar and second premolar |
| | MnF | Mandibular foramen |
| | Gonion | The inferior point of the mandibular angle area |
| | RamusPost | The most posterior point of the ramus on the MnF plane |
| | RamusAnt | The most anterior point of the ramus on the MnF plane |
| | 4,5MnFP | The point on the MnF plane that intersects 4,5 at a right angle |
| | 5,6MnFP | The point on the MnF plane that intersects 5,6 at a right angle |
| Lines | RamusAP | Line between the RamusAnt and the RamusPost |
| | Postborder | Line between the gonion and the RamusPost |
| Planes | Occlusal plane | A Plane that contains 3 points: IM, 36MBC, and 46MBC |
| | Sagittal plane | A plane that passes through the IM and is normal to the occlusal plane |
| | MnF plane | A plane that passes through the MnF and is parallel to the occlusal plane |
| | Molar coronal plane | A plane that passes through both 36MBC and 46MBC and is normal to the occlusal plane |
| | MnF coronal plane | A plane that passes through both MnFs and is normal to the occlusal plane |
| | Posterior ramus coronal plane | A plane that passes through both RamusPosts and is normal to the occlusal plane |

59 adult patients aged 18-25 years were allocated to the adult group. 17-year-olds were excluded in both groups, because that age may cause confusion in the point of growth.

### Data collection and evaluation

The Digital Imaging and Communications in Medicine (DICOM) file for each mandible was extracted from the CT data. Mandibular CT images were 3-dimensionally reconstructed from the DICOM files using Simplant 13.0 (Materialize Dental, Leuven, Belgium) software, which allows for the 3-dimensional reconstruction and measurement of CT images. The anatomic landmarks and reference planes for each mandible were defined and labeled (Table I). These landmarks and reference planes were used to measure the 3-dimensional position of the MnF (Figures 1 and 2).

The position of the MnF was measured on the basis of lengths and angles of anatomic structures in the oral cavity, which can be used in IANBA, as follows (Table II): the perpendicular height from the MnF to the occlusal plane; the distance between the MnF and the contralateral 4,5MnFP; the angle between the sagittal plane and the line passing through the MnF and the contralateral 4,5MnFP; the distance from the RamusAnt to the MnF; and the perpendicular distance from the IM (midpoint between the mesial incisal tips of the both mandibular central incisors) to the molar coronal plane (Figures 3-5).

The individual measurements of both sides, including lengths and angles, were averaged as 1 value. A descriptive statistical analysis was conducted for the individual lengths and angles of the adult group. The statistical analysis for the growth group was conducted using a regression test for the change in individual lengths and angles caused by mandibular growth with age as a variable. The data were tested using the SPSS 14.0 statistical software package (SPSS, Chicago, IL, USA).

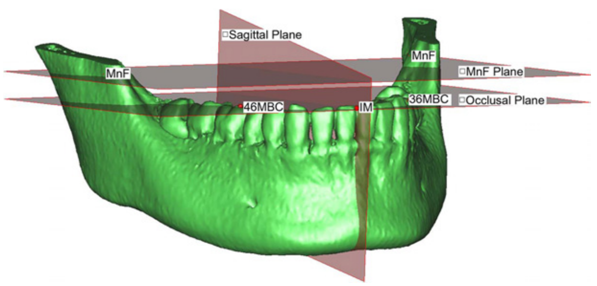


Fig. 1. Occlusal plane, sagittal plane, and MnF (mandibular foramen) plane.

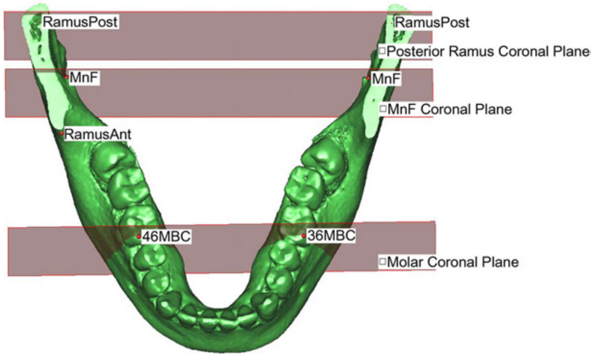


Fig. 2. Molar coronal plane, MnF coronal plane, and posterior ramus coronal plane.

## RESULTS

The mean age of the adult group was 22.5 ± 1.9 years (mean ± SD; range 18-25 years), and the sex ratio was