The Intraosseous Course of the Mandibular Incisive Nerve in the Mandibular Symphysis

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The use of the mandibular symphysis as a source of autogenous bone grafting material has been well documented. Currently, no references in the literature describe the intraosseous distribution of the neurovascular complex anterior to the mental nerve with respect to its position buccolingually and apicocoronally. The objective of this study was to evaluate the distribution of the incisive nerve and measure its location buccolingually and apicocoronally in the anterior mandible and determine its possible significance to clinical practice. According to macroscopic dissection, the mandibular incisive nerve is a normal structure that typically extends closer to the midline than previously reported. To reduce postoperative neurovascular morbidity, this should be considered when using the mandibular symphysis as a source of autogenous bone or during placement of implants in the anterior mandible. (Int J Periodontics Restorative Dent 2001;21:591–597.)

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The longevity and success of osseointegrated implants in the treatment of completely and partially edentulous patients has been well documented.1–4 One of the main diagnostic factors in patient evaluation for the placement of dental implants is sufficient quantity and quality of available bone that is free of anatomic limitations at the desired implant location.

Placement of an endosseous implant requires sufficient bone volume for complete bone coverage. Several surgical procedures have been described to augment bone volume, including autogenous grafts or bone substitutes and membrane techniques. Uncertain predictability and limited application of these alternative methods often indicate the use of autogenous grafts. Various donor sites have been described in the literature, including the calvarium,5 tibia,6 rib,7 and iliac crest.2

Because of the morbidity associated with these donor sites, alternative areas for graft harvest have been suggested: maxillary tuberosity,8 palate,9 zygomatic arch,10 mandibular coronoid processes,11
and chin bone. Linkow reported on the use of “bone plugs” harvested from the symphysis with trephine burs for ridge augmentation prior to or during placement of blade-vent implants. Comparative studies between iliac crest or rib grafts and chin grafts imply minimal complications at the mandibular donor site and significantly less resorption associated with chin grafts.

A recent article on the use of chin bone as a source of autogenous graft material stated the advantages of the mandibular symphysis over other intraoral sites. First, the chin has topographic accessibility. Second, there is significant volume of cancellous and cortical bone for harvesting. The disadvantages are possible altered facial contour, postoperative sensory disturbances, and prolapsed symphysis muscles (“chin droop”). That article recommended minimal harvesting of cancellous bone to prevent paresthesia at any level. The article also discussed the potential variability of the neurovascular complex anterior to the mental foramen, hypothesizing that there may be branching of the nerve that runs within the symphysis.

Parameters of the osteotomy site have been set as follows: 5 mm from the inferior border of the chin, 5 mm from the apex of the dentition, and 5 mm anterior to the mental foramen. The depth of the cut is dependent on the thickness of cortical bone, and it is limited to 2 to 3 mm of cancellous bone. The authors of the previously mentioned article performed a retrospective analysis of 48 chin grafts and reported the most serious long-term complication to be altered nerve sensation, which was found in 6% of the cases. An increased amount of cancellous bone removed correlated with an increase in postoperative paresthesia. The article described two methods of harvesting bone from the chin: a four-ring design and a six-ring design. The four-ring design is used when moderate bone harvesting is required. Overlapping 8-mm trephine cuts are made into the mid-symphysial region. A six-ring design is used when more bone is necessary. When a four-ring design was used to harvest from the chin, 5% of the cases had paresthesia, versus 9% with the six-ring design. In a comparative study of the use of the chin as a source of autogenous bone, 12% of teeth had pulpal canal obliteration and 4% had negative pulpal sensibility when bicortical bone grafts were obtained from the symphysis.

Kohavi and Bar-Ziv reported a case in which a patient complained of discomfort from two implants placed in the anterior mandibular area. Computerized tomographic (CT) images revealed the passage of a distinct structure, surrounded by cortical bone, which extended from the right mental foramen anteriorly and passed through the lower part of the right and left implants. The structure was identified as the incisive nerve. The incisive nerve, one of the terminal branches of the inferior alveolar nerve (IAN), extends anteriorly within the mandible after separating from the mental nerve and forms a plexus that supplies the canines and incisors. The authors stated that this nerve plexus is usually delicate and is not readily detectable by conventional radiography or CT.

Descriptions of the intra-mandibular course of the IAN and its associated canal have been based on dissections and noninvasive images of the mandible. A study of 50 mandibles described the IAN as a single entity that travels up to the mental foramen, where it branches into incisive and mental branches. A detailed study of eight mandibles reviewed the morphologic pattern of the IAN and described three different types of distribution of the IAN. In type I, the IAN courses toward the mental foramen as a single large structure close to the molar root apices. It terminates at a mental arborization, with offshoots forming the incisor nerve plexus. In type II, the IAN is located substantially “lower down” in the mandible, and the dental branches are arranged obliquely. In type III, the IAN branches early, producing two large branches posteriorly that provide the innervation to the molar and premolar region, whereas the inferior branch extends medially to innervate the incisor canine region. An extensive network of communicating branches was present in each type, forming connections with those from outside, including the mylohyoid nerve.

One study gave a more detailed description of the morphologic arrangement of the human IAN. Twenty-nine human mandibles were dissected, and
particular attention was given to the anatomic presentation on the canine-incisor region. The incisive branch was described as continuing from the mental branch by curving downward and medially to innervate the canines and incisors. An earlier study examined 160 hemimandibles of fetuses at term and newborns and found that the terminal branches of the incisive nerve extend anteriorly up to the central incisor. The author disagreed with Olivier with respect to the nerves crossing the midline, and there is still controversy as to whether the terminal branches cross the midline.

There are no anatomic references in the literature as to the buccolingual depth of the cut into the mandibular symphysis. Currently, no evidence in the literature describes the position of neurovascular complexes in the anterior mandible with respect to their position buccolingually and apicocoronally. Knowing an accurate neurovascular anatomic location, while understanding that there will be human variability, would be an important diagnostic tool prior to placing implants in the anterior mandible.

The purpose of this study was to evaluate the intraosseous distribution of the incisive nerve and measure its location buccolingually and apicocoronally in the anterior mandible and determine its possible significance to clinical practice.

**Method and materials**

Twelve human mandibles were randomly selected from a group of 25. They were obtained from the Willed Body Program, Department of Pathology and Lab Medicine, UCLA School of Medicine. The cadaver mandibles were received with skin, subcutaneous fat, and muscles still intact and preserved in formalin. The cadaver mandibles were left in water for 30 minutes to remove the embalming solution from the specimens.

All soft tissue was dissected, leaving the mental nerve exiting at the mental foramen intact. The specimens were then placed in decalciﬁying solution containing 9.5%wv hydrochloric acid and 1%wv ethylenediaminetetraacetic acid (EDTA) for a period ranging between 8 and 12 days. The state of decalcification was assessed at 24-hour intervals by determining ease of cortical plate removal with tissue forceps. The specimens were removed from the solution and left in running water for 30 minutes to rinse out acid contents, then stored in formalin. The dissections were performed from the buccal, starting at the entry point of the IAN at the ramus of the mandible. Buccal cortical bone was removed using a scalpel and ﬁne forceps. The ﬁner nerve branches extending through to the tooth root apices and periodontal areas were traced as far as macroscopic dissection allowed. The cortical bone around the exit of the mental nerve was left intact to maintain its position. The cancellous bone on the lingual side of the nerve was left intact to avoid disturbing the nerve’s location. Removal of the cortical plate did not disturb the position of the IAN. The cortical bone in the area of the canines and lateral incisors was removed to expose their apices. The morphologic features of the areas were examined and photographed.

Once the incisive nerve was located, measurements were made with a Boley gauge (Hu-Friedy) to the nearest millimeter. Measurements were then recorded as follows: (1) the distance from the mesial aspect of the mental foramen to the most anterior location of the incisive nerve, (2) the distance from the apex of the canine to the incisive nerve, (3) the distance from the apex of the lateral incisor to the incisive nerve, (4) the distance from the inferior border of the mandible to the incisive nerve, (5) the distance from the crest of bone to the inferior border of the mandible, and (6) the buccolingual position of the incisive nerve. The latter measurement was obtained by measuring the buccolingual width of the anterior mandible prior to dissection and later subtracting the distance from the lingual plate of the anterior mandible to the position of the incisive nerve.
Results

Demographic data of the cadavers are listed in Table 1. All measurements were taken from the right and left sides of the mandibles, with one exception. The first mandible in the study was hemi-sected, and only the right side was evaluated macroscopically. One of the 12 mandibles was edentulous, and canine and lateral measurements could not be measured for this particular specimen.

The mean length of the mandibular right incisive nerve was 20.58 ± 2.99 mm and 21.45 ± 2.06 mm for the left (Fig 1). The mean distance of the right incisive nerve to the apex of the lateral incisor was 7.40 ± 3.69 mm and 8.0 ± 3.33 mm for the left (Fig 2). The mean distance from the right incisive nerve to the inferior border of the mandible was 10.75 ± 2.45 mm and 10.36 ± 1.62 mm for the left (Fig 3). The mean distance to the apex of the canine on the right side was 5.73 ± 2.76 mm and 6.10 ± 2.02 mm for the left (Fig 4). The mean apicocoronal measurements of the anterior mandible were 29.75 ± 3.52 mm for the right and 29.73 ± 3.95 mm for the left (Fig 5). The position of the incisive nerve was 2.67 ± 0.65 mm from the buccal plate on the right side and 2.64 ± 0.67 mm on the left (Fig 6).

Discussion

The use of the mandibular symphysis as a source of autogenous bone grafting material has been well documented. The most serious long-term complication has been altered nerve sensation. Currently, no references in the literature describe the intrasosseous distribution of the neurovascular complex anterior to the
Fig 3  Distance from the inferior border of the mandible to the incisive nerve.

Fig 4  Distance from the incisive nerve to the apex of the canine.

Fig 5  Measurements of the apicocoronal height of the anterior mandible taken from the canine region for both right and left sides.

Fig 6  Measurements of the buccolingual distance of the nerve from the buccal plate. The width of the anterior mandible was measured with a Boley gauge prior to removal of the cortical plate. Once the nerve was located, measurements were taken from the lingual plate to the buccolingual position of the nerve. The difference between these two numbers was determined to be the distance from the buccal plate to the incisive nerve.
mental nerve with respect to its buccolingual and apicocoronal position.

A dissection of human mandibles revealed that in all cases, the IAN divided into its incisive and mental branches. The incisive nerve distributed fibers to the individual teeth; however, measurements were not recorded. Pogrel et al. assessed innervation of the mandibular incisors by the mental nerve. They tested the hypothesis that some sensory innervation to the mandibular incisors comes from reentry of the terminal branches of the mental nerve through the labial plate of the anterior mandible. Ten cadavers were dissected to determine whether the mental nerve crossed the midline or reentered the labial plate. It was concluded that branches of the mental nerve may reenter the labial plate to supply the mandibular incisors and there is cross-over innervation from the contralateral mental nerve. This explains how labial infiltration injection will anesthetize the mandibular incisors. In that study, however, the investigator did not look at the intraosseous course of the incisive nerve. The dissections performed were of the soft tissue to trace the mental nerve once it exited the mental foramen.

Examination of cross-sectional CT images of implants placed in the anterior mandible revealed the passage of a distinct structure, surrounded by cortical bone, which extended from the right mental foramen anteriorly and passed through the lower part of the right and left implants. The structure, which was identified as the incisive nerve, also emerged from the left mental foramen and advanced toward the midline. It was concluded that the possibility of nerve variations in the anterior region of the mandible must be considered to prevent possible trauma to the adjacent tissues when
placing implants. It is interesting to note that Kohavi and Bar-Ziv17 described the distribution of the incisive nerve as an "atypical variation."

In several articles,18-21 mandibles have demonstrated an incisive branch; unfortunately, no measurements were taken. The findings from the present investigation demonstrate a prominent incisive nerve that was typical of each of the mandibles dissected (Figs 7 to 11). The mean length of the incisive nerve to the midline was 20.58 mm on the right side and 21.45 mm on the left, leaving only a 4- to 8-mm midline band that was not innervated. This study also demonstrated that the incisive nerve is located as far as 14 mm from the inferior border of the mandible and as close as 7 mm. The incisive nerve is located 7 to 8 mm from the apex of the lateral incisor and 5 to 6 mm from the apex of the canine. According to our macroscopic dissection, the incisive nerve did not reach the area below the central incisors.

It is evident that the mandibular incisive nerve is a normal structure that typically extends closer to the midline than previously reported. To reduce postoperative neurovascular morbidity, this should be considered when using the mandibular symphysis as a source of autogenous bone or during placement of implants in the anterior mandible.

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References