Computed Tomographic Diagnosis and Localization of Bone Canals in the Mandibular Interforaminal Region for Prevention of Bleeding Complications During Implant Surgery

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In this study, computed tomograms (CTs) of 70 patients were examined for visible vascular canals in the mandible as well as for their localization, incidence, diameter, and content. All patients examined showed at least 1 lingual perforating bone canal in the mandible. Since such vascular canals are encountered regularly, routine CT examination is recommended prior to implant surgery to help avoid severe bleeding complications during the placement of implants in the interforaminal region. (Int J Oral Maxillofac Implants 2001;16:68–72)

Key words: *dental computed tomography, dental implants, intraoperative complications, mandibular bone canals*

Currently, the placement of endosseous implants involves minimally invasive oral surgical procedures that are normally without significant risk. In the mandible, the interforaminal region is considered the region of choice because of its favorable anatomic conditions and the rarity of life-threatening complications. Some of the complications described in the literature[1–9] can arise during host site preparation, in which the mandibular lingual compact bone can become severely perforated. As a result, a vessel in the floor of the mouth can be injured, resulting in massive swelling with acute dyspnea and—in the overwhelming number of cases—with a latency period of several hours. In this regard, a recent publication[10] thoroughly examined and classified the blood supply to the floor of the mouth and also mentioned computed tomography (CT) as an imaging method that allows visualization of bone canals through which the examined vessels course through the mandibular bone.

Dental CT can be considered perhaps the most effective diagnostic presurgical examination method, since it allows 3-dimensional visualization.[11] In addition to the patient's individual skeletal conditions, CT also provides information concerning the sites of vessel entry from the floor of the mouth into the mandible, which appear as bone canals.

The aim of this study was to examine by means of CT the presence, incidence, and location of lingual vascular canals in the mandibles of an unsorted group of normal patients.

MATERIALS AND METHODS

Seventy patients were examined in this study using dental CT. Forty-two of the subjects were female and 28 were male. The age of the patients, most of whom were Central Europeans, ranged between 16 and 81 years, with a mean age of 49.5 years.

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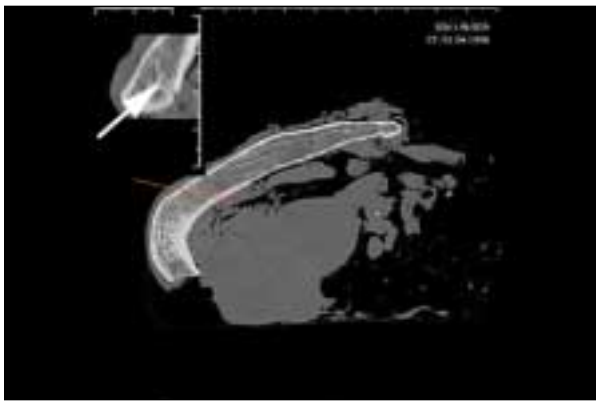

Fig 1 Parasagittal CT slice showing the full length of a bone canal (*arrow*) in a cadaveric mandible.

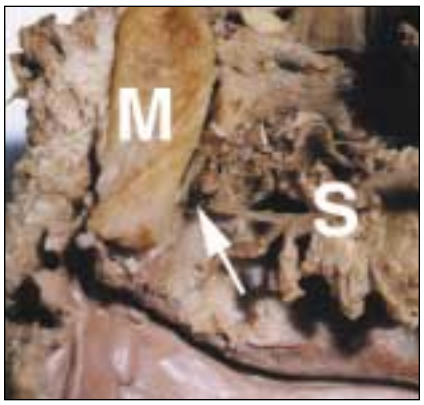

Fig 2 Branches of the sublingual artery (S) entering the mandible (M) via bone canals (*arrow*) from the lingual.

High-resolution scans of the mandible were acquired with a conventional CT scanner (Tomoscan SR-6000, Philips, Eindhoven, The Netherlands) using a standard dental CT investigation protocol (1.5-mm slice thickness, 1.0-mm table feed, 120 kV, 75 mA, 2 sec, high-resolution bone filter). The CT images were examined for the presence of bone canals entering the mandible. The entrances to the canals were located on the lingual side of the mandible. The diameter of the canals, the distance between the entrance to the canal and menton (Me), and the height of the entrances to the canals in relation to the inferior mandibular margin were examined. In addition, the intraosseous courses of the canals were described. Patients' orthopantomograms (OPGs) were also examined for possible evidence of bone canals.

In a second step, the content of the bone canals was examined. Computed tomographic images of 2 cadaveric mandibular specimens were obtained to visualize the bone canals (Fig 1). The specimens were then dissected at these exact points, and the entrances to the canals were exposed. Branches of vessels of the floor of the mouth were discovered that coursed into the mandible through these bone canals (Fig 2). All of these branches were from the sublingual artery and its respective satellite veins. No nerve fibers were detected macroscopically.

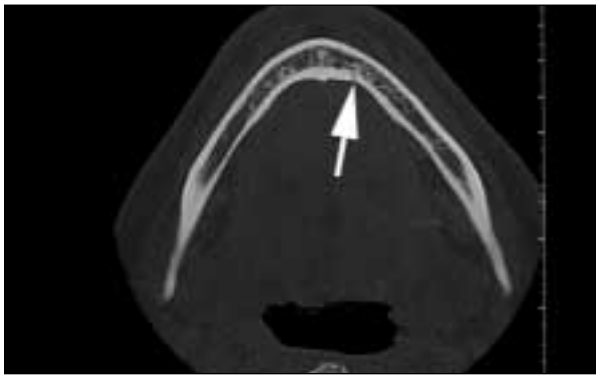

Fig 3 Axial CT slice of the inferior mandible, demonstrating a lingual bone canal (*arrow*).

RESULTS

All patients examined in this study showed at least 1 lingual perforating bone canal in the mandible (Fig 3). The number of canals ranged from 1 to 5 per patient, with the majority of patients showing 2 canals. The diameter of the entrances to the canals ranged from 0.2 mm to 1.2 mm (mean value 0.8 mm).

Because of the canal locations, they were subdivided into the following 2 groups:

- Group 1: Entrances to the canals that were located to the left and the right of the mental spines (Figs 4a and 4b). Thirty-seven patients (52.9%) with a total of 43 canals belonged to this group. In 31 (44.3%) patients, 1 lateral canal was found on each side of the mandible, and in 6 (8.6%) patients, 2 lateral canals were found on each side. The entrances to the canals were located at a distance of 12.2 mm to 34.0 mm from Me (mean value 23.3 mm). The distance

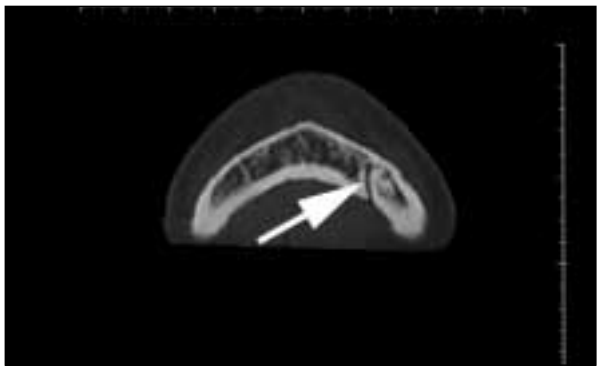

Fig 4a Paracoronal CT slice of the inferior mandible demonstrating a group 1–classified bone canal (*arrow*).

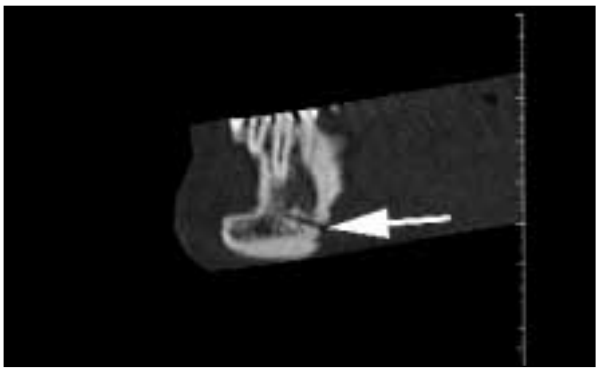

Fig 4b Parasagittal CT slice of the canine region demonstrating a group 1–classified bone canal (*arrow*).

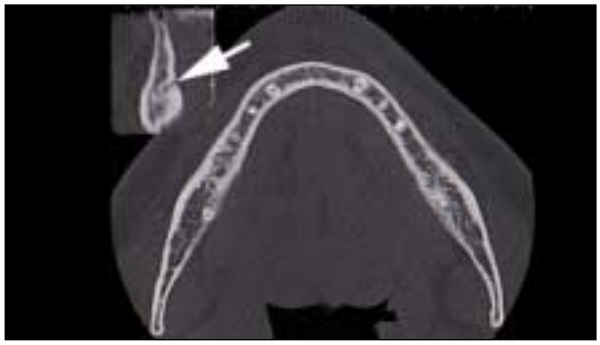

Fig 5 Orthoradial CT reconstruction of the midline (*straight line*) of the mandible demonstrating a group 2–classified bone canal (*arrow*).

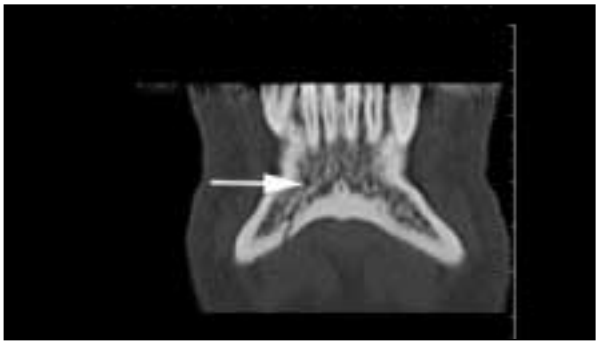

Fig 6 Paracoronal CT slice of the mandible showing a bone canal entering Spee's canal (*arrow*).

between the entrance to the canal and the inferior mandibular margin ranged between 0 mm and 19 mm, with a mean value of 5.9 mm.

- Group 2: Entrances to the canals that were located in the midline of the mandible, in the region of the mandibular symphysis (Fig 5). All 70 patients (100%) showed this configuration. In total, the patients showed 101 canals located in the mandibular midline (sometimes several canals were present in a single patient). Forty-five patients (64.3%) showed 1 canal, 19 patients (27.1%) had 2 canals, and 6 patients (8.6%) had 3 canals. The entrances to the canals were located at a distance of 0 mm to 23 mm from the inferior mandibular margin (mean value 10 mm).

Course of Bone Canals

Lateral bone canals always showed an intraosseous course in the ventral direction and were located in the lingual region of the mandible over their entire length. The bone canals located in the symphyseal region, on the other hand, coursed through the entire buccolingual dimension of the mandible in many cases. McDonnell et al[12] described a canal in the midline of the mandible, half of which coursed through the bone in a buccolingual direction. Bone canals do not follow a uniform course in the sagittal plane. Interestingly, 3 of the examined patients (10%) in the present study demonstrated 1 canal each that entered Spee's canal (Fig 6) on the same side. Unlike the CTs, the patients' OPGs did not provide any clear observations of discernible bone

canals, since such delicate structures could not be distinguished from the surrounding bone as a result of the tissue overlap with this method.

Symmetry

As far as the examined group of patients is concerned, it was not possible to demonstrate any side-related symmetry of distribution of the bone canals. Only 11 of 37 patients (29.7%) demonstrated entrances to canals on both sides of the mental spine.

DISCUSSION

Because of previous reports[1–9] on the occurrence of life-threatening bleeding as a result of erosion of a vessel of the floor of the mouth during the placement of interforaminal implants, the vascular supply to the floor of the mouth has already been investigated.[13–15] However, very few of these studies examined lingual vascular canals in the mandible. McDonnell et al[12] described a lingual foramen containing an artery, which developed from an anastomosis of the 2 sublingual arteries. However, they stated that it was difficult to visualize this foramen radiographically. Hofschneider et al[10] were the first to mention the possibility of visualizing bone canals by means of CT. The present study clearly demonstrates the high incidence of such bone canals, which were encountered in all patients examined. As a result of the small diameter of the canal entrances, which border on the limit of resolution, the measures do not precisely correspond to real measures, but only roughly indicate the projection of the canals.

Bone canals are clinically relevant to the placement of endosseous implants in the interforaminal region, as this region may also present complex anatomic conditions, apart from the small buccolingual diameter of the mandible. Complex anatomic conditions may include a very pronounced sublingual fossa, which has been described in the literature[7,16,17] and which may contribute to a lingual perforation of the bone during host site preparation as a result of the reduced lingual bone volume. Dental CT imaging of anatomic and pathologic jaw conditions can prove beneficial when performed prior to implant placement.[18]

Because of potentially severe clinical complications resulting from a perforation of the lingual compact bone and injury of a vessel during the placement of interforaminal implants, and because of the proximity of the vessels in the floor of the mouth to the lingual mandibular bone demonstrated in this study, routine identification of bone canals through CT evaluation is recommended. In addition, the radiation dosage can be reduced considerably (by approximately 75%) for this particular examination, as compared to conventional CT examinations.[19] To calculate a cost/benefit ratio for the use of CT, further data on the incidence of complications should be collected and considered a work in progress.

SUMMARY

Although dental CT is a relatively complex examination method involving relatively high exposure to radiation, the method has nevertheless proven effective as a standard for visualization of the anatomic conditions of the maxilla and the mandible. The high incidence of lingual bone canals, along with the reported cases of severe postoperative bleeding complications, underline the need for an efficient tool for accurate presurgical diagnosis. Dental CT seems to be particularly suitable, since the high-resolution analysis of the entire body of the mandible provides not only an image of the skeletal conditions, but also of the sites of entrance of the vessels into the lingual mental region. In addition, the value of CT in the forensic aspects of sufficient documentation, diagnosis, and treatment planning should not be underestimated.

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