Distribution of Endosseous Bony Canals in the Mandibular Symphysis as Detected with Cone Beam Computed Tomography

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Purpose: *The purpose of this article was to investigate the distribution of endosseous bony canals in the anterior mandible using cone beam computed tomography (CBCT) technology.* ***Materials and Methods:*** *Two hundred ninety-nine images based on CBCT of the anterior mandible were analyzed for the presence of endosseous canals. The bony canals were observed in relationship to the adjacent anatomical structures, and relationships between their topographic variability and patient age and gender were analyzed.* ***Results:*** *Bony canals were found in the anterior mandible in almost 86% of the examined patients, independent of age and gender. The highest regional frequency was seen in the midline area, followed by the lateral incisor and canine regions. The length of the canals ranged from 5 to 15 mm (mean, 10.55 mm). Multiple (two or three) canals were also observed in approximately 9% of the scans. Varying appearances of these bony canals in the symphysis region were also demonstrated.* ***Conclusions:*** *Endosseous canals in the mandibular symphysis were found using CBCT scans. CBCT seems to be an important diagnostic technique for evaluation of the exact distribution of bony canals in the symphysis region that may help reduce the risk of surgical complications.* Int J Oral Maxillofac Implants 2012;27:273–277

Key words: *anterior mandible, blood vessels, complications, cone beam computed tomography*

There is an increasing demand for rehabilitation of the edentulous mandible by means of osseointegrated implants; therefore, knowledge of variations in the anatomical dimension and morphology of the endosseous arteries is crucial. The anterior mandible is also an area of significant clinical interest, especially as a donor site for bone grafting. The parasymphyseal region on the lingual side of the mandible is a well-vascularized area, with a rich blood supply that lies very close to the interforaminal lingual cortical plate. This area of the mandible has three important arteries traversing it and supplying it: the inferior alveolar artery (and its branch, the mylohyoid); the facial artery (and its branch, the submental artery); and the lingual artery (and its branch, the sublingual artery). The artery most commonly implicated or affected in implant dentistry–related procedures is the sublingual artery, the perforation of which may have significant life-threatening consequences.[1] Some authors[2,3] have asserted that the main supplier of circulation to the anterior region is the submental artery; others[4] have stated that the inferior alveolar artery is the main artery. Thus, there is no clear consensus within the scientific community about the artery/arteries that supply the anterior part of the mandible. Because of this lack of consensus and the excellent vascularization of this region, it is extremely important for clinicians to visualize the vessel characteristics to improve treatment planning and thereby reduce the chance of errors during surgical procedures.

Recently, cone beam computed tomography (CBCT) has been used in other areas of dentistry and seems especially suitable for diagnosis in implant therapy.[5] Specifically, CBCT has been shown to improve the visibility of anatomical structures that cannot be observed clearly on regular panoramic or other intraoral

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Table 1 Distribution of Canals with Respect to Age and Gender

	Age (y)		
Area	Women (n)	Men (n)	All subjects (n)
0	47.90 (21)	44.16 (19)	46.13 (40)
L	47.88 (43)	45.52 (29)	46.93 (72)
L1	45.43 (7)	36.56 (9)	40.44 (16)
M	44.57 (98)	47.80 (45)	45.59 (143)
R	35.57 (7)	45.50 (18)	42.72 (25)
R1	29.50 (2)	45.00 (1)	34.67 (3)
All sites	45.28 (178)	45.48 (121)	45.36 (299)

Pearson chi-square = 17.665; degrees of freedom = 5; $P = .003$.
Likelihood ratio chi-square = 17.627; degrees of freedom = 5;
$P = .003$. NOTE: Two cells had expected counts of fewer than 5.

radiographs.[6] A good understanding of the presence of anatomical structures cannot be emphasized strongly enough. Many dentists have described surgical complications with severe bleeding during implant placement, as well as after surgery,[7–14] caused by perforation of the lingual plate and damage to blood vessels in the soft tissues on the lingual surface of the mandible. Therefore, the aim of the present study was to analyze the presence and distribution of the bony canals within the mandibular body in the anterior mandible using CBCT.

MATERIALS AND METHODS

CBCT scans from subjects who had given informed consent for the use of their images for educational and scientific purposes were used in the present study. The CBCT images had been obtained in a specialized radiologic clinic in Frankfurt, Germany, for diagnostic purposes before implant treatment or other oral surgical procedures. A KaVo 3D eXam unit was used to obtain 1-mm-thick scans at 120 kV and 20 to 35 mAs. In general, cone beam units use a divergent cone/pyramid-shaped beam to obtain multiple planar projections in a single rotation. These cone-shaped beams are similar to those of x-ray units used for two-dimensional radiography. Cone beam units can function with patients sitting or standing. The anterior mandible was evaluated in the interforaminal region, with the teeth used as anatomical landmarks to assess the relationships between the blood vessels. The teeth were divided into areas for statistical analysis as follows: The area of the central incisors was designated as M (midline), the region of the left incisors was designated L, the left canine/first premolar area was labeled as L1, the right incisors were labeled as R, and the right canine/first premolar region was designated as R1.

The images were evaluated for the presence of endosseous blood vessels; their frequency was evaluated by two independent examiners. A Cohen kappa analysis was done to evaluate interexaminer agreement. Associations between age and gender with blood vessel frequency and distribution were analyzed. Statistical evaluation of the anatomical characteristics, specifically the distribution and length of the vessels, was also performed. All statistical analyses were done using Minitab software (version 15).

RESULTS

CBCT scans from 299 subjects (121 men, 178 women) were used for the present study. The patients ranged in age from 13 to 93 years, with a mean age of 45.36 years (Table 1). Endosseous canals were observed in about 85% of the examined subjects (Fig 1). The frequency of bony canals was similar in men and women; however, variations in the distribution, length, and orientation of the canals were observed. The canals ranged between 5 and 15 mm in length, with a mean length of 10.55 mm. Multiple canals (two or three) were observed in about 9% of the scans, in superior, inferior, and/or middle distributions. These canals presented in the form of branches and were observed in both men and women (Fig 2). Figures 3 to 5 show examples of canals observed on CBCT scans.

DISCUSSION

By means of CBCT scans, the present study demonstrated the frequency and distribution of bony canals within the anterior mandible, which is a common site for implant placement and other oral surgeries. Some studies[15,16] have observed important blood vessels and related foramina in the anterior mandible. Some of these studies have also highlighted the difficulty of visualizing these important anatomical landmarks by means of conventional radiography.

McDonnell et al[15] established the lingual foramen as a consistently common structure of the anterior mandible and described the frequency with which simple radiographic approaches failed to reveal it. The authors also reported difficulty in visualizing the bony canals and the inclined path of the bone canals in relation to the lingual surface of the mandible on radiographic survey. The high frequency of bony canals observed using CBCT imaging confirms the higher sensitivity of this diagnostic technique. Suzuki and Sakai[16]

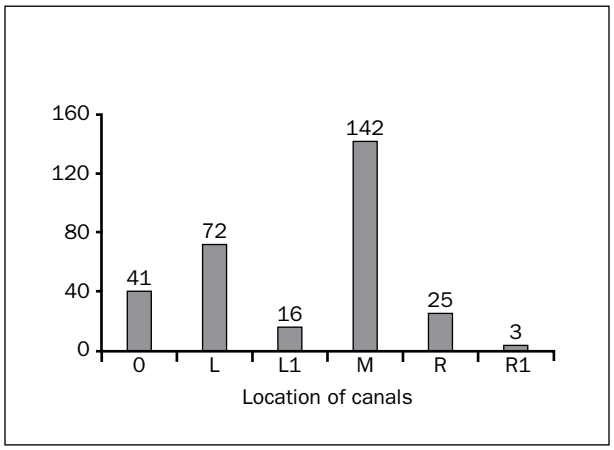


Fig 1 Frequency of endosseous canals in various areas of the mandibular symphysis. 0 = no canals observed; M = central incisor region; L = region of the left incisors; L1 = left canine and first premolar areas; R = right incisor region; R1 = right canine and first premolar region.

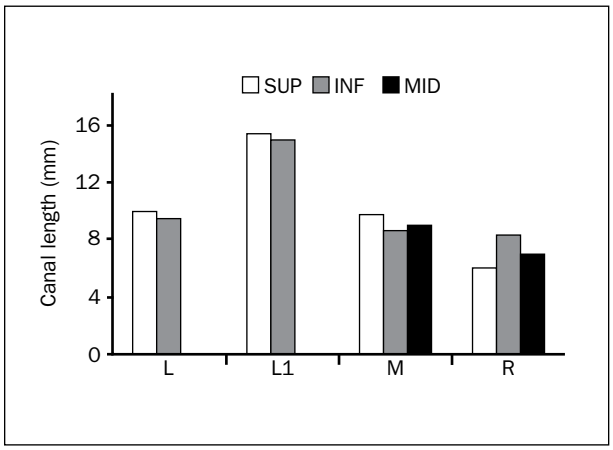
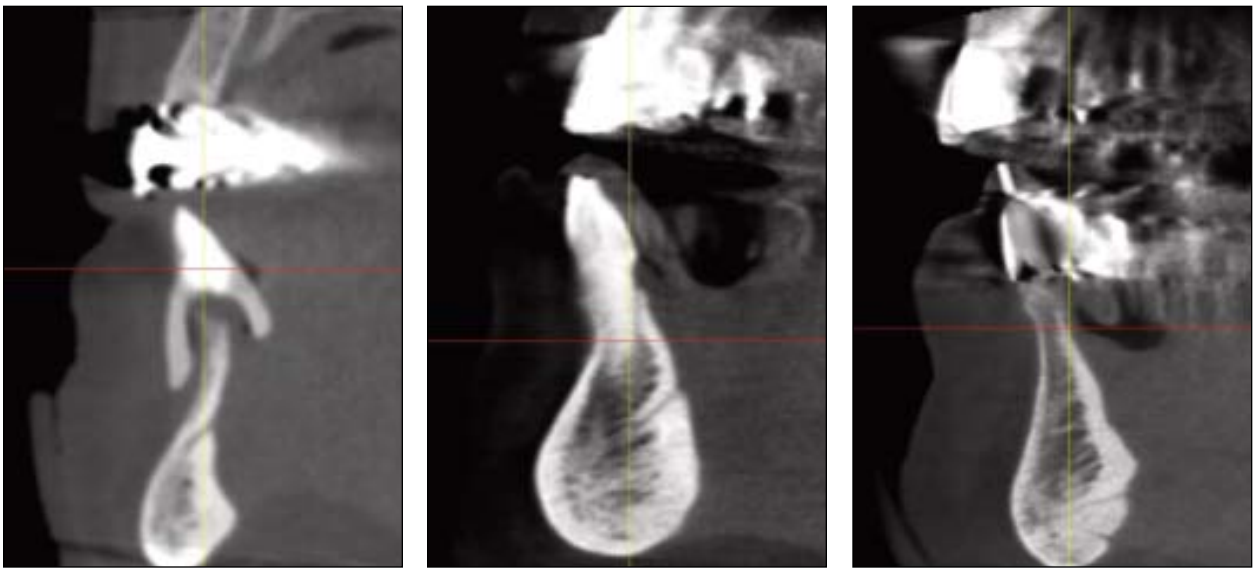


Fig 2 Lengths of multiple bony canals and their relationship to the mandible. SUP = superior branch; INF = inferior branch; MID = middle branch.



Figs 3 to 5 CBCT scans showing endosseous canals in the mandibular symphysis.

showed a frequency of 76% for the lateral lingual foramen and an average distance from the inferior margin of the mandible of 5 mm. In a CT study, Tepper et al[17] observed a frequency of approximately 50% of the lateral lingual foramen. The present study also reinforces the high number and prevalence of bony canals in the anterior mandible. The high frequency of the lingual foramen observed by many authors in dissection studies confirms the need for better anatomic evaluation of the area because of the possible presence of arteries related to these foramina.

The high number of bony canals shown in the present study was assumed to be related to the greater number of examined cases and possibly to better demonstration of anatomic structures by means of CBCT technology. CT scans have been used in the oral and maxillofacial area to better assess the presence of lingual foramina in the superior and inferior genial spines and in the lateral area of the mandible. Tepper et al[17] and Gahleitner et al[18] attempted to clarify the relationship between the foramina and the intraosseous routes of the canals on CT images. Tagaya et al[19]

studied the frequency of the foramina and their canals on the lingual surface of the mandible in 200 patients using CT scans. The frequency of the lingual foramen in the medial region was 100%, and in the lateral regions it was 80%. They found at least one foramen in all patients. A high position of the mental spine was seen in 190 patients, a middle position of the mental spine was observed in 99 patients, and a low position of the mental spine was observed in 114 patients. Lateral lingual foramina were found in 160 patients and bilaterally in 88 patients. They also reported seeing more than one foramen at each location. The present findings are in accordance with the study of Tagaya et al,[19] with a high prevalence of bony canals, especially in the midline area.

The resolution of spiral CT may not be sufficient to depict the trabecular bone structure of cancellous bone, making it difficult to identify anatomical relationships between the endosseous arteries and their proximity to a surgical site. It is also more difficult to visualize smaller anatomical structures using spiral CT. In a CT study, Yoshida et al[20] observed the lingual canals inside the mental region in the right and left sides of the mandible in cadavers. The spinal foramen connected with the mental canal at the midline of the mandible in six patients (of 47 dry skulls examined). In addition, Katakami et al[21] investigated the regional frequency and anatomical properties of mandibular lingual foramina using CBCT. Their results confirm the greatest frequency of foramina in the midline area, followed by the second premolar and canine areas. Multiple lingual foramina were observed only in the midline areas. The present findings are in agreement with these studies, except that the current study found a high incidence of these bony canals in the midline, in addition to occasionally more than one canal, as observed on CBCT scans.

CBCT technology has been used in other aspects of dentistry to better correlate bone quality with implant primary stability.[5] According to a study of 61 implants in 20 patients, the thickness of compact bone based on CBCT scans had a strong correlation to implant stability. Studies have also shown the superiority of CBCT technology over panoramic and periapical radiography. Sherrard et al[6] showed the accuracy and reliability of tooth and root lengths when measured using CBCT in seven pig heads. The authors showed that CBCT-assisted tooth length and root length measurements were not significantly different from the actual lengths; the mean differences were less than 0.3 mm. The periapical radiographic measurements significantly underestimated root lengths and overestimated tooth lengths.

A blood vessel injury during implant placement may disturb the wound-healing process, leading to soft tissue proliferation of the endothelial cells from the blood vessels around the implant surface and possibly compromising implant integration. Detailed diagnosis of symphyseal morphology, including the shape and inclination of the alveolar ridge as well as osseous undercuts of the mandibular body, is crucial prior to surgery in the anterior mandible. The present study demonstrated linear-type anatomical landmarks in the anterior mandible, similar to blood vessel morphology, in addition to the presence of foramina. Previous studies have shown foramina in the anterior mandible. Another study that used ultrasound identification and quantitative measurement (Doppler)[22] showed that the sublingual artery is the main blood supply to the anterior mandible. According to the information obtained from this study, intraosseous bleeding is a fairly likely possibility even without perforation of the lingual cortical plate, especially in patients with advanced resorption of the mandible.

CONCLUSIONS

Comprehensive information on endosseous canals in the symphysis of the mandible is clinically significant. Confirmation of the locations of any lateral lingual foramina is one of the reasons that computed tomography or limited cone beam computed tomography is recommended in presurgical assessment for implant placement.

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