CLINICAL ORAL IMPLANTS RESEARCH

Erdem Kilic
Selim Doganay
Murat Ulu
Nükhet Çelebi
Ali Yikilmaz
Alper Alkan

Determination of lingual vascular canals in the interforaminal region before implant surgery to prevent life-threatening bleeding complications

Authors' affiliations:
Erdem Kilic, Nükhet Çelebi, Alper Alkan, Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Erciyes University, Kayseri, Turkey
Selim Doganay, Ali Yikilmaz, Department of Radiology, Faculty of Medicine, Erciyes University, Kayseri, Turkey
Murat Ulu, Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Katip Çelebi University, İzmir, Turkey

Corresponding author:
Nükhet Çelebi
Erciyes University, Faculty of Dentistry
Department of Oral and Maxillofacial Surgery
Kaysery, Turkey
Tel.: +90 533 572 1296
Fax: +90 352 438 0657
e-mail: NCelebi@erciyes.edu.tr

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Abstract

Objectives: Profuse hemorrhage and airway obstruction may occur during or after the implant surgery in the interforaminal region. The prevention from this complication requires identifying the location of the mandibular lingual vascular canals (MLVCs). The purpose of this study was to evaluate the anatomical variations of MLVCs and to determine the safety margins for implant placement in interforaminal region.

Materials and methods: Computer tomography (CT) images of 200 consecutive patients were reexamined retrospectively by a radiologist and a maxillofacial surgeon to evaluate the presence of the MLVCs entering the mandible. The diameter and the number of the canals, the distance between the entrance of the canal and mandibular midline, and the height of the entrances of the canals from the inferior mandibular margin were measured.

Results: Two hundred and thirty-six median lingual canals (MLCs) and 159 lateral lingual canals (LLCs) were found in 200 patients. Significant differences were found between the number of lingual canals in the midline and canine regions ($P < 0.001$).

Conclusion: There is a potential risk of complications due to the injuries of the vessels entering the lingual cortical bone through a number of bone canals during implant placement in the interforaminal region.

Implant placement in the anterior mandible is regarded as a rather safe and predictable procedure, and this region is considered to be free from main neurovascular structures. On the contrary, anterior mandible is not free from inherent risks, some of which are associated with life-threatening complications. The most frequently reported complications are profuse hemorrhage and airway obstruction (Darriba & Mendonga-Carıdad 1997; Woo et al. 2006; Dubois et al. 2010). The majority of these cases were attributed to the perforation of the lingual cortex with resulting injury to the sublingual artery (SA) (Kalpidis & Konstantinidis 2005; Woo et al. 2006). SA is a major branch of lingual artery (Bavitz et al. 1994), of which branches supply the floor of the mouth and enter the mandible through bony canals (Tepper et al. 2001). Recent reports have demonstrated the diameter, frequency (Gahleitner et al. 2001; Gültekin et al. 2003; Lustig et al. 2003), and the contents (McDonnell et al. 1994; Lustig et al. 2003) of these mandibular lingual vascular canals (MLVCs) through various imaging techniques. However, their presence and locations are variable (Sutton 1974; McDonnell et al. 1994; Liang et al. 2007).

Preventing serious hemorrhage in the anterior mandible during or after implant surgery requires to identify the location of the MLVCs. Computer tomography (CT) is therefore used as an imaging method that allows visualization of bonny canals in which the examined vessels course through the mandibular bone (Tepper et al. 2001).

The purpose of this retrospective study was to evaluate the anatomical variations of MLVCs on CT images of 200 patients and to determine the safety margins for implant placement in the interforaminal region.

Materials and methods

The study protocol was approved by the Local Ethics Committee of the Erciyes University. Two-hundred patients (132 men, 68 women;

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mean age: 53.17 years), who underwent maxillofacial CT examination for different purposes, such as dental implant planning, examination of cysts and tumors, and dentofacial deformities, in Erciyes University, Medical School, Department of Radiology between September 2009 and September 2010, were included in this study. The CTs were reexamined retrospectively by a radiologist and a maxillofacial surgeon to evaluate the presence of the MLVCs entering the mandible.

High resolution scans of the maxillofacial region were obtained with a 16 detector row CT system (Light Speed 16, GE Medical Systems, Milwaukee, Wisconsin, USA) using a standard procedure. Patients were examined in supine position with 5-mm collimation at 5-mm intervals, using the settings of 120 kV, 300 mA, and a 0.5 sec acquisition time. Reconstruction of the data in 1.25-mm slice thickness and 1.25-mm intervals was performed. All images were obtained with both bone window and parenchyma-window settings. Scans were examined at a window of 3900–4000 Hounsfield units (HU), and a level of 500–550 HU, for bone evaluation.

The CT images were interpreted using multiplanar reconstructions, maximum intensity projection, and volume-rendering techniques on a workstation (Advantage Workstation 4.2 Light Speed 16, GE Medical systems Milwaukee, Wisconsin, USA).

Axial and coronal CT images were evaluated to establish the presence and positions of the MLVCs. The diameter and the number of the canals, the distance between the entrance of the canal and mandibular midline, and the height of the entrances of the canals from the inferior mandibular margin were measured.

Statistical analyses

The data normality was assessed using Shapiro-Wilk's test, and the valves are expressed as either mean ± SD or median (25th–75th percentiles). To compare the differences between the number of lingual canals in the midline and canine regions, Chi-square analysis was used. Analysis were performed using IBM Statistics SPSS 20.0 (SPSS, Chicago, IL, USA), considering $P < 0.05$ statistically significant.

Results

The results of this study showed only one MLVC in %40.5 of all patients. The number of canals ranged from 1 to 5 per mandible. Of 200 patients, 70 (35%) had two; 32 (%16) had three; 14 (%7) had four; and three (1.5%) had five mandibular lingual canals.

Two characteristic locations of mandibular lingual foramen were observed in this study: one is located on the mandibular midline (MLC, Fig. 1), and the other is on the canine-premolar regions (LLC, Fig. 2). Other than these two typical locations, a few number of LLCs were determined at posterior to the mental foramen.

Two hundred and thirty-six MLCs and 159 LLCs were found in 200 patients. One hundred and fifty-six patients (78%) had one, 36 (18%) had two, and one (0.5%) had three MLCs. Eighty-four (52.8%) LLC in 70 patients were located at the right side, and 75 (47.2%) in 68 patients were at left side (Table 1).

There was no significant difference between genders with regard to the number of MLCs ($P = 0.564$) and LLCs ($P = 0.648$).

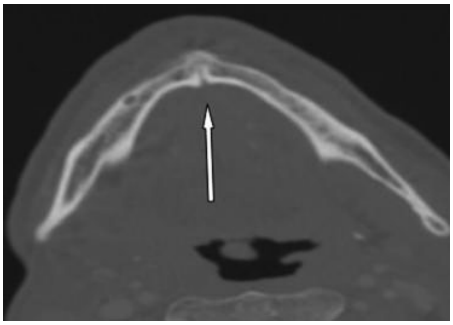

Fig. 1. Mandibular lingual canal on the midline.

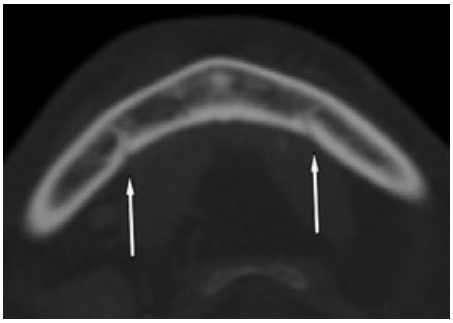

Fig. 2. Mandibular lingual canal on the canine-premolar region.

Table 1. **Number of lingual vascular canals**

Number of canals	Median lingual canal (236) Patients (%)	Lateral lingual canal (159) Patients	
		Right (84) (%)	Left (75) (%)
0	7 (3.5)	130 (65)	132 (66)
1	156 (78)	57 (28.5)	61 (30.5)
2	36 (18)	12 (6)	7 (3.5)
3	1 (0.5)	1 (0.5)	

Significant differences were found between the number of lingual canals in the midline and canine regions ($P < 0.001$, Figs 3 and 4).

The diameters of the canals, their distance to midline, and/or inferior border are summarized in the Table 2.

Discussion

An increasing number of studies have clearly described life-threatening complications caused by profuse bleeding from the implantation site after dental implant surgery in the interforaminal region of the mandible (Darriba & Mendonga-Carıdad 1997; Hofschneider et al. 1999; Kalpidis & Konstantinidis 2005; Woo et al. 2006; Dubois et al. 2010). This complication may result in development of a large hematoma within the floor of the mouth, leading to upper airway obstruction, and may require hospitalization with intubation or an emergency tracheostomy. The vessels entering the mandible through bone canals from the lingual side can cause such bleeding when they are injured during host site preparation. Therefore, clinicians must give particular attention to this region during implant surgery.

Possible existence of mandibular lingual canals and the blood supply of the interforaminal region have previously been investigated in some studies of CT (Tepper et al. 2001), ultrasound (Lustig et al. 2003), and cadaver dissection (Hofschneider et al. 1999). Hofschneider et al. (1999) defined the involving vessels those enter the lingual cortical plate of the mandible through bone canals to be the terminal branches of the SA, which originates from the lingual artery.

The number and location of MLCVs are variable. Rosano et al. (2009) found one to three MLVCs in 60 mandibles in 80 adult human cadavers. Nevertheless, the extent of their study was limited to the bone canals located on the lingual side of the mandibular midline. In another study, however, evaluating dental CTs of 32 patients, two typical locations of the MLVCs were defined as either in or near the midline or lateral lingual canals (LLCs) in both premolar regions. The authors reported at least one lingual canal in all patients, with the total number of canals ranging from one to five for each patient (Gahleitner et al. 2001). Consistently with previous reports, the present study demonstrates the high incidence of MLVCs in 200 patients, being, in our knowledge, the largest sample number in the literature. The number of the existing bone canals was differed one

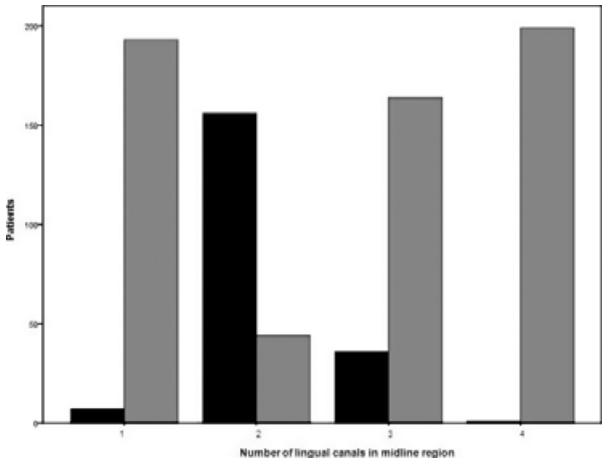

Fig. 3. The number of lingual canals in the midline region.

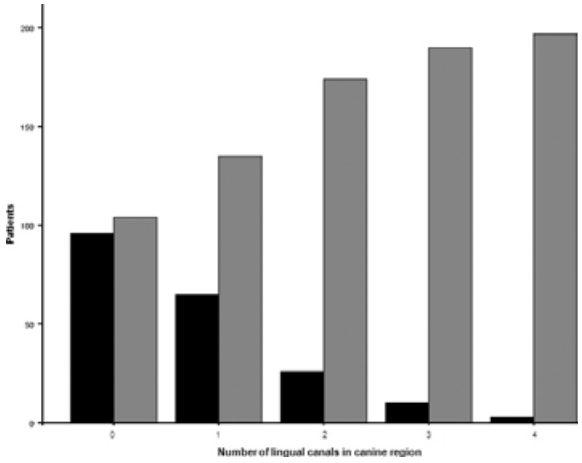

Fig. 4. The number of lingual canals in the canine region.

Table 2. **Evaluation of median lingual canals (MLCs) and lateral lingual canals (LLCs)**

	MLC	LLC (right)	LLC (left)
Number of canals	236 (193/200)	84 (70/200)	75 (68/200)
Diameter (mm) Median	0.57–1.91 ± 0,213655 1.0100	0.48–1.54 ± 0,20547 0.9200	0.59–1.61 ± 0,17940 0.9100
Distance to inferior border (mm) Median	1–19 ± 4,28729 13.0000	2–22 ± 4,05908 7.0000	3–35 ± 5,49491 7.0000
Distance to midline (mm) Median	–	1.24–23 ± 6.251 13.20	1.5–22.17 13.19

to five. Two typical locations at the mandibular midline and canine-premolar regions and an additional location at posterior to mental foramen were defined in our study. These findings confirm the potential risk of vessel injury in the floor of the mouth during implant surgery in the interforaminal region.

In the edentuolus patient, bone loss is horizontal in the anterior region of the mandible. A relatively long implant drilled in a vertical position can easily perforate the lingual cortex (Mardinger et al. 2007). Therefore, the distance from the MLVCs to the alveolar crest is clinically relevant to implant surgery for it may limit the length of implant to be placed. In addition to MLVCs, a very pronounced sublingual fossa may contribute to the risk of lingual perforation (Tepper et al. 2001). In the present study, because the distance between bone canals and the alveolar crest is effected by bone resorption, we measured the vertical distance to the inferior border. The mean distance of MLVCs to the inferior border of the mandible was 12.28 mm, whereas LLCs was 8.18 mm, suggesting an implant length to be chosen leaving a safety margin of at least 8 mm from the inferior border.

The diameter of the MLVCs is also important as it is proportional with the diameter of the entering artery and the potentially increased risk of hemorrhage (Gahleitner et al. 2001). Lustig et al. (2003) found the diameter of involving arteries to be 0.18–1.8 mm, with a blood flow of 0.7–3.7 ml/min. This explains the profuse hemorrhage due to the injury of the vessels. In our study, the mean diameter of the MLCs was 1.05 mm and of LLCs was 0.92 mm. These results indicated that CT imaging of the MLVCs in the interforaminal region is essential during dental implant planning.

The findings of our study suggest that there is a potential risk of complications due to the injuries of the vessels entering the lingual cortical bone through a number of bone canals during implant placement in the interforaminal region. These complications can result in life-threatening emergencies requiring clinicians be aware of, to recognize and manage such situations. Evaluation of mandibular anatomical structures with CT imaging should therefore be an essential part of dental implant planning, and particular attention must be given in the interforaminal region during host site preparation.

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