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Original Article

Evaluation of medial lingual foramen with cone-beam computed tomography in a Turkish adult population

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Abstract

Aim: The aim of this study is to characterize the anatomical findings of the MLF in a Turkish population, using cone-beam computed tomography (CBCT).

Methodology: The CBCT images of 350 untreated patients (164 male, 186 female ranging in age between 18 and 65) were included in this study. The distribution of MLFs were determined in axial, sagittal, and coronal planes by considering gender and side. For statistical evaluation, a chi-square test was used to analyze independent samples. P<0.05 was considered statistically significant.

Results: At least 1 canal was observed in all subjects (n = 350). The most common result was a single canal. Among the 164 male patients (46.86%), 98 had 1 canal (59.75%); 59 had 2 canals (35.97%); and 7 had 3 canals (4.26%). Among the 186 female patients (53.14%), 134 (72.04%) had 1 conduit or canal; 49 (26.34%) had 2 canals; and only 3 case (1.61%) presented with 3 canals. Difference between genders was statistically significant.

Conclusions: Vascular canals and anastomoses presence in anterior mandible which are sufficient for severe hemorrhage complications. The distribution of MLFs must be taken into account during presurgical planning.

Keywords: Lingual foramen, cone-beam computed tomography, lingual artery, anatomic variation

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Introduction

The anterior mandible is considered to be a relatively safe and predictable area for surgical interventions because of the high bone density of the region and the absence of critical neurovascular structures (1, 2). Mandibular symphysis is a good region for the implant placement to support overdentures or fixed partial dentures and also preferred as an autologous donor graft area in need of bone augmentation (3, 4).

Although interforaminal region is known as a safe area to place implants, recent reports have indicated that perforation of the lingual cortex during implant surgery can cause life-threatening hemorrhage and severe hematoma formation on the floor of the mouth by injury of the vessels of the mandibular lingual foramen (5, 6).

The medial lingual foramen (MLF) has been described as a small hole in the lingual zone of the mandible, in the midline. Radiographically, it can be observed as a small radiolucent circle, situated approximately 10 mm under the interapical line of the incisor teeth. It has a variable size, with a diameter usually 1 to 2 mm, but with possible variations in location, number and length all of which make it difficult to detect the lingual foramen with conventional radiographic evaluation (7, 8).

Cadaver studies concluded that the MLF is penetrated by branches from submental artery, sublingual artery and anastomosis of these or other branches from facial and lingual arteries (9-11). The blood supply originating from MLF is sufficient to cause severe bleeding, which can lead to the upper airway obstruction because of the hematoma that forms underneath the mylohyoid muscle (12). Immediate surgical interventions for hemostasis is the solution for this condition.

A horizontal bone resorption pattern is primarily seen from the labial side after anterior tooth extractions which results in a lingually angulated trajectory of mandible. If not considered well before implant placement, increased risk of lingual perforations and unfavorable prosthetic angulations may result from unsuccessful treatments (13).

To avoid such complications, it is essential to determine an anatomic structure of the area by cone-beam computed tomography (CBCT) during the presurgical planning. The enhanced diagnostic range of CBCT increases the clinician's confidence and predictability by providing precise information of 3-dimensional bone structure (14).

Previous investigations have stated that mandibular lingual foramina show important variations anatomically in samples of human mandibles from different geographical regions (15,16). The aim of this study is to characterize the anatomical findings of the MLF by the CBCT images acquired from 350 patients in a Turkish adult population.

Materials and Methods

A retrospective, quantitative study of CBCT images from patients seen in the Oral and Maxillofacial Radiology Department of the İzmir Katip Çelebi University was conducted. The study was performed in accordance with the Declaration of Helsinki. After the approval of the local ethics committee, written informed consent was obtained from all patients.

Systematically healthy patients older than 18 years with good quality mandibular CBCT images and without cystectomy, resection or trauma history were included. Radiographies that didn't allow the study of the whole lower third of the jaw or the presence of artifacts that did not allow measurement of the medial mandibular lingual canal, images of low quality, tumoral or cystic pathology, impacted teeth and patients with skeletal diseases or syndromes were excluded from the study.

A total of 350 subjects who underwent a CBCT examination for dental treatment planning between January 2012 and December 2017 were included. There were 164 (46.86 %) men and 186 (53.14 %) women, with a mean age of 32 years, ranging from 18 to 65 years. CBCT images were obtained in supine position, using NewTom 5G CBCT machine (QR Srl, Verona, Italy), operating at 110 kVp, 1-20 mA with a 15×12 field of view (FOV) and standard resolution mode (0.2mm voxel size).

The distribution of MLFs was detected on NNT station (QR Srl, Verona, Italy) using the "zoom" tool and manipulation of brightness and contrast on a computer monitor (The RadiForce MX270W features a 27-inch large screen size and a 2560 x 1440 high-resolution) under dim lighting conditions by an experienced oral and maxillofacial radiologist. All the measurements were performed by the same clinician. The anterior mandible was carefully examined on and around the midline in order to detect the lingual foramina and vascular canals. The MLFs were analyzed by considering gender and side. The number of the canals detected on the sagittal slice was recorded. (Fig. 1)

25% of the CBCT scans were randomly selected and reevaluated by the same investigator 2 weeks after the first evaluation to determine intraexaminer reliability using the intraclass correlation coefficient (ICC).

Statistical Analysis

Data analysis was performed using the Statistical Package for the Social Sciences version 23.0 (SPSS Inc., Chicago, Il., USA). One way Anova and Scheffe post hoc tests were performed. P value <0.05 was considered as statistically significant. Spontaneous debondings in the thermal cycle process were considered as 0 MPa.

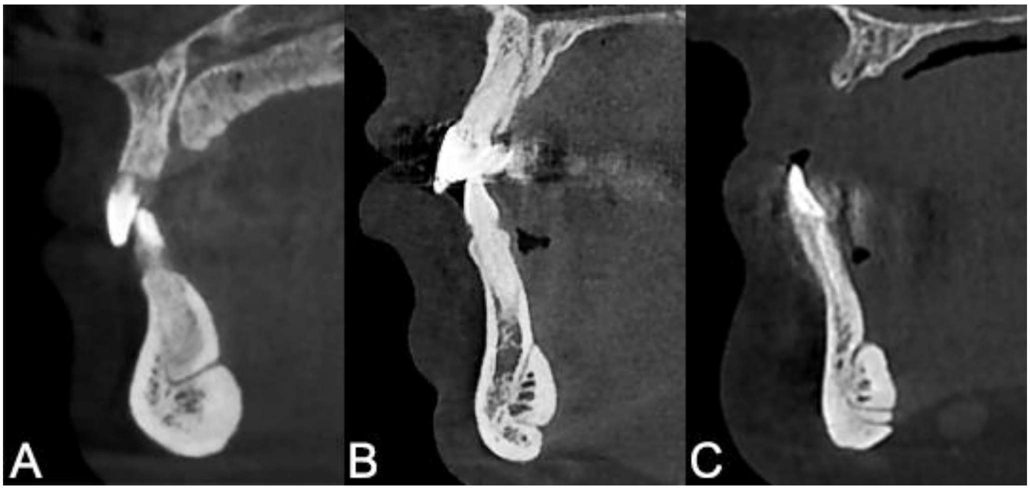

Figure 1. Sagittal CBCT sections of various patients. **A.** Shows a mandibular midline image with a single lingual vascular canal **B.** Two lingual canals in the midline of the mandible **C.** Three lingual canals in the midline of the mandible

Results

The number of MLF was counted in this CBCT radiographic study. At least 1 canal was observed in all subjects (n = 350, 100%). The most common result was a single canal, followed by two and rarely three canals (Table 1). None of our patients presented with 4 canals.

Among the 164 male patients (46.86%), 98 had 1 canal (59.75%); 59 had 2 canals (35.97%); and 7 had 3 canals (4.26%). Among the 186 female patients (53.14%), 134 (72.04%) had 1 conduit or canal; 49 (26.34%) had 2 canals; and only 3 case (1.61%) presented with 3 canals. Difference between genders was statistically significant in all frequency groups.

Table 1. Percentage of medial lingual foramen distribution among the patients

	1 Canal	2 Canals	3 Canals	Total
Female	134 (72,04%)	49 (26,34%)	3 (1,61%)	186
Male	98 (59,75%)	59 (35,97%)	7 (4,26%)	164
Total	232 (66,28%)	108 (30,85%)	10 (2,85%)	350

Chi-square=6.756 p=0.0341

Discussion

Defining the anatomy using radiological methods during preoperative planning can help the clinician take the proper decisions regarding a surgical treatment. Several authors describe the location, vascularization and innervation of the MLF, warning about the possible risks that may have been caused from surgical damage (13, 17, 18). There are case reports that have pointed out the life-threatening hematoma in the floor of the mouth because of injury of mandibular lingual vessels in the interforaminal region (19,20). If hemorrhage occurs, it could lead to life-threatening upper airway obstruction.

In studies analyzing lingual foramina, there are some discrepancies in the measured values of the MLF, which can be attributed to the differing methods used to examine the jaw. Some classic studies were made on dry jaws or cadavers; in other studies, ethnicity was not a parameter or there was no standardization in the parameters.

McDonnell et al. have reviewed several anatomic studies and reported the difficulties of the conventional techniques for radiologic depiction of the median lingual canals (MLC) (21). If the X-ray beam is not parallel to the lingual canal, it cannot be depicted; this was the case in 49% of the specimens. Poyton and Pharoah also reported that the MLC was visible in only a small percentage of conventional radiographs of the mandibular incisor region (22).

A study conducted by Dreiseidler et al. using CBCT examination, the lingual vascular canals in the mandibular midline were detected 100% of the cases, while with orthopantomogram (OPG) their presence was observed only in 4.2% of the cases (4). It was indicated that OPG can offer insufficient information on the presence of the MLF, due to the superimposition of the cervical vertebras and the limitations of two-dimensional imaging.

CBCT imaging proves to be superior to OPG and other conventional imaging methods when investigating anatomical structures of the jaws. However, all CBCT examinations must be justified on an individualized need basis just as all other radiographic examinations (23-27).

Tepper et al. found that all of 70 patients in their study most of whom were Central Europeans, ranged between 16 and 81 years had at least a canal in the mandibular midline. Forty-five patients (64.3%) showed 1 canal, 19 patients (27.1%) had 2 canals and 6 patients (8.6%) had 3 canals (28). A similar study conducted by Sanchez-Perez et al included 111 Caucasian patients, of whom, 49 (44.1%) were men and 63 (56.4%) were women showed that among the 49 men, 28 had 1 canal (57.1%); 19 had 2 canals (38.8%); and 2 had 3 canals (4.1%). Among the 62 women, 43 (69.4%) had 1 canal; 18 (29%) had 2 canals, and only 1 case (1.6%) presented with 3 canals (8).

Vandewalle et al. identified a distinct foramen at or just superior to genial spines in %98 of specimens in their study that used a total of 390 Indian human cadavers and also emphasized there were differences among ethnic groups (17). The ethnic differences were not evaluated in the present study, as most of the patients were Turkish. Further studies focusing to investigate the effects of ethnic factors should be carried out to clarify this. Our results are consistent with aforementioned studies apart from minor differences which can be assumed to be based on ethnic factors.

Conclusions

Vascular canals and anastomoses presence in anterior mandible which are sufficient for severe hemorrhage complications. CBCT examination is able to reveal multiple anatomic features of the mandible such as MLF that must be taken into account during presurgical planning. The enhanced diagnostic features of CBCT increase the clinician's predictability and may help to reduce the risk of complications.

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