VIA MEDICA

ORIGINAL ARTICLE

Folia Morphol.
Vol. 80, No. 4, pp. 916–922
DOI: 10.5603/FM.a2020.0128
Copyright © 2021 Via Medica
ISSN 0015–5659
eISSN 1644–3284
journals.viamedica.pl

Investigation the anterior mandibular lingual concavity by using cone-beam computed tomography

M. Çitir[1], K. Gunduz[2], P. Kasap[3]

[1]*Department of Dentomaxillofacial Radiology, Faculty of Dentistry, University of Gaziosmanpasa, Tokat, Turkey*
[2]*Department of Dentomaxillofacial Radiology, Faculty of Dentistry, University of Ondokuz, Mayis, Samsun, Turkey*
[3]*Department of Statistics, Faculty of Science and Literature, University of Ondokuz, Mayis, Samsun, Turkey*

[Received: 14 July 2020; Accepted: 10 October 2020; Early publication date: 16 October 2020]

Background: *In the presence of lingual concavity in the mandible, the cortical perforation and consequently the life-threatening intraoral haemorrhages obstructing the upper respiratory tract may be seen during the surgical intervention. The present study was aimed to determine the prevalence of lingual concavity in the interforaminal region and its relationship with gender and dentate status.*
Materials and methods: *The images of 106 patients who underwent cone-beam computed tomography (CBCT) between 2016 and 2017 in Department of Dental and Maxillofacial Radiology Department of Faculty of Dentistry of Ondokuz Mayıs University were retrospectively examined. The images were obtained using a Galileos device (98 kVp, 15–30 mA). The bone height and width in interforaminal region and the frequency of lingual concavity were analysed.*
Results: *Of patients involved in the present study, 42.5% were male and 57.5% were female After the examinations performed, the bone was morphologically classified into four classes as type I lingual concavity, type II inclined to lingual, type III enlarging towards labiolingual and type IV buccal concavity. Type III (77.9%) was the most common type in the anterior region, followed by type II (16.5%), type I (4.7%) and type IV (0.9%). The lingual concavity angle was 76.5 ± 3.69º and the concavity depth was 2.09 ± 0.34 mm.*
Conclusions: *The lingual concavity can be detected by using the cross-sectional CBCT images and the complications related with lingual cortical perforation can be prevented.* (Folia Morphol 2021; 80, 4: 916–922)

Key words: anterior, concavity, cone-beam computed tomography, dental implant, mandible

INTRODUCTION

The use of removable dentures in the mandible with total or partial edentulous provides not sufficient comfort, function and aesthetics for the patient. The mandibular two-implant-retained overdenture prosthetic, in case of insufficient stability and retention of complete denture has become a standard treatment protocol [40]. The interforaminal region is considered a reliable area for placing dental implants in the mandible. In this region, there are important

Address for correspondence: M. Çitir, DDS, Gaziosmanpasa University, Faculty of Dentistry, Department of Dentomaxillofacial Radiology, Tokat, Turkey, tel: 03562124222-7913, e-mail: mesudectr@hotmail.com

This article is available in open access under Creative Common Attribution-Non-Commercial-No Derivatives 4.0 International (CC BY-NC-ND 4.0) license, allowing to download articles and share them with others as long as they credit the authors and the publisher, but without permission to change them in any way or use them commercially.

neurovascular structures such as lingual foramen, incisive canal, mental foramen, and anterior loop. The sublingual branch of lingual artery, the submental branch of facial artery, and the incisive branch of inferior alveolar artery anastomosis in the anterior mandible [15, 17, 19]. This rich vascular plexus courses nearby the lingual cortex in interforaminal region. The perforation in lingual cortex and consequently a vascular damage may develop in this region during dental implant placement or other surgical interventions, especially in presence of concavity. The severe haemorrhage, upper respiratory tract obstruction and haematoma on the mouth floor may develop as a result of the vascular damage [7, 15, 16, 31, 32]. Up to 24% of haemorrhage complications have been reported after implant placement [11]. Although the minimal perforation developing in lingual cortex has been previously considered to be benign, it has been observed that the haematoma developing on the mouth floor may reach severe levels. Moreover, mycotic pseudoaneurysms, which result in rupture of the internal carotid artery and lingual arteries, are also very rare complications [1, 12]. Severe bleeding can occur during the procedure, minutes or 6–7 hours later [19, 28, 39, 42].

The clinical palpation of alveolar crest offers limited information in the presence of concavity [5, 41]. In examination with intraoral film and panoramic radiography, however, the buccolingual dimension cannot be assessed. It is necessary to use the cross-sectional imaging methods such as cone-beam computed tomography (CBCT) in order to obtain detailed information about the volume and morphology of bone and relationship of tooth root with neurovascular structures [15, 17, 24].

The present study aimed to determine the prevalence of lingual concavity in interforaminal region and to detect relationship of concavity with gender and dentate status.

MATERIALS AND METHODS

The approval for the present study was obtained from the Clinical Research Ethics Committee of Ondokuz Mayıs University (B.30.2.ODM.0.20.08/795-900). In this study, the images of 106 patients who underwent CBCT for dental implant or having loss of teeth in mandible between 2016 and 2017 in Department of Dental and Maxillofacial Radiology Department of Faculty of Dentistry of Ondokuz Mayıs University were retrospectively examined. The images containing pathological formations such as cyst, tumour etc. in interforaminal region were not included in analyses. All the CBCT images were obtained from Galileos (Sirona Dental Systems, Bensheim, Germany) device with parameters of 98 kVp, 15–30 mA, 15 × 15 mm image area, 2–5 s irradiation and 14 s scanning. The synchronous reconstruction was performed by using SIRONA Sidexis XG 2.61 viewer software with isotropic voxels having 12-bit grey-scale depth and 0.25 mm3 size. All the examinations and measurements were performed using 27” LCD monitor (3.7 MP, 68 cm, 2560 × 1440 resolution) (the RadiForce MX270W, Eizo Nanao Corporation, Ishikawa, Japan) under low level of illumination. In cross-sectional images, the height, width and morphology of the bone were evaluated in the anterior region of the mandible. To standardise the measurements, the region 4–6 mm anterior of the mental foramen was examined. The bone in the anterior region was classified as type I lingual concavity, type II inclined to lingual, type III enlarging towards labiolingual and type IV buccal concavity (Fig. 1). The parallel lines were drawn tangentially to the most buccal and most lingual point of the cortical bone. The distance between parallel lines was determined as the maximum bone width. The distance between the tip of alveolar crest and the cortical border of mandibular inferior was recorded as the maximum bone height. The horizontal distance at the deepest point of concavity was noted as concavity depth. The angle between mandibular inferior cortical border and lingual cortex (for type I and type II, the most lingual point was referenced) was determined as lingual slope angle. The slope angle of the lingual concavity was determined as the lingual concavity angle (for type I) (Fig. 2).

This cross-sectional study was reviewed and approved by the Ethics Committee for Human Research of the University of 19 Mayıs. (B.30.2.ODM. 0.20.08/795-900) mention under heading of ethical approval.

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Statistical analyses

The data obtained from the examined images were analysed using SPSS 20.0 (Statistical Package for Social Sciences) for Windows. Data were presented as mean ± standard deviation and frequency. The

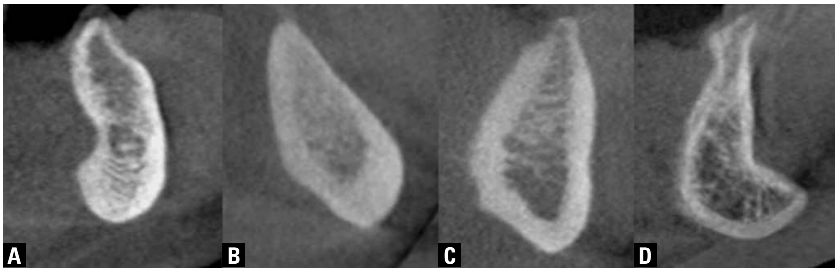

Figure 1. Cross-sectional cone-beam computed tomography images representing the mandible shapes; **A.** Type I lingual concavity; **B.** Type II inclined to lingual; **C.** Type III enlarging towards labiolingual; **D.** Type IV buccal concavity.

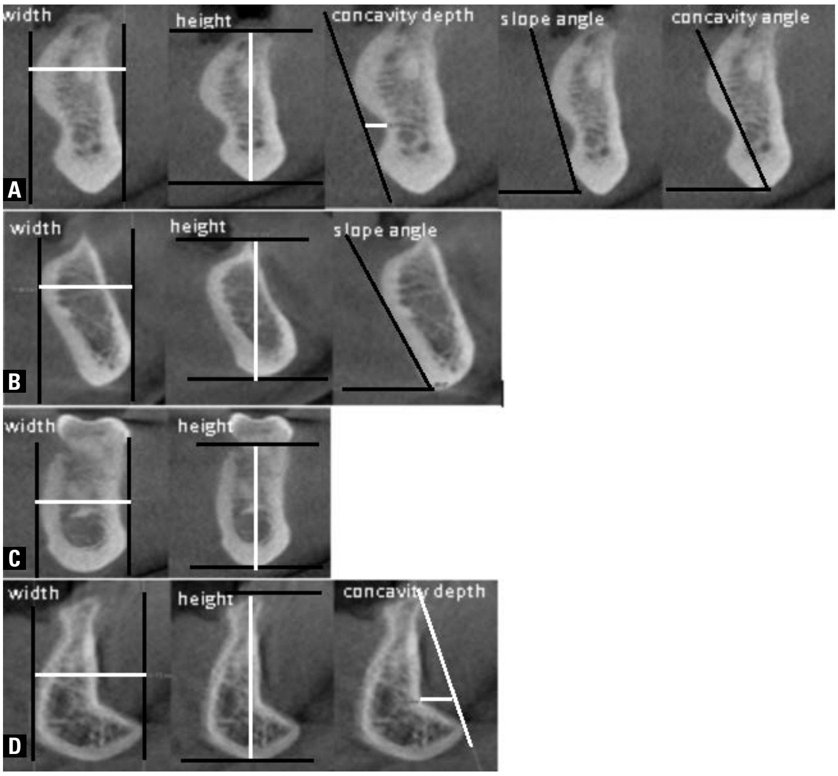

Figure 2. A–D. Schematic representation of the cone-beam computed tomography images for the measurement of bone type I, II, III and IV, recpectively.

relationship between bone types and age, gender, and dentate status was analysed using the χ^2 test. The paired sample t-test was used for determining the relationship between height and width of bone and age/gender. The p value 0.05 was considered to be statistically significant.

RESULTS

Of the patients, 45 (42.45%) were male and 61 (57.55%) were female. The mean age of the patients was 55.7 ± 10.31 years (range, 23–77). In interforaminal region, 37 of the patients were edentulous, 58 were partially edentulous, and 11 were dentate. The shape of the anterior mandible was classified into four types, as shown in Figure 1. Of the patients, 4.7% had type I, 16.5% had type II, 77.9% had type III and 0.9% had type IV bone morphology. Type III was the most common type in both gender and dentate status. Type I was more common in females and type II was more common in males (Table 1). There was a significant relationship between the bone type and gender ($p = 0.005$). Type I was more common in dentate patients and type II was more common in edentulous patients. There was a significant relationship between the bone type and dentate status ($p = 0.000$; Table 1).

Table 1. Distribution of bone types by gender and dentate status

	Male	Female	Dentate	Edentulous
Type I	1.11%	7.38%	5.34%	3.7%
Type II	24.44%	10.65%	4.58%	35.8%
Type III	73.55%	81.15%	88.56%	60.5%
Type IV	0.9%	0.82%	1.52%	–

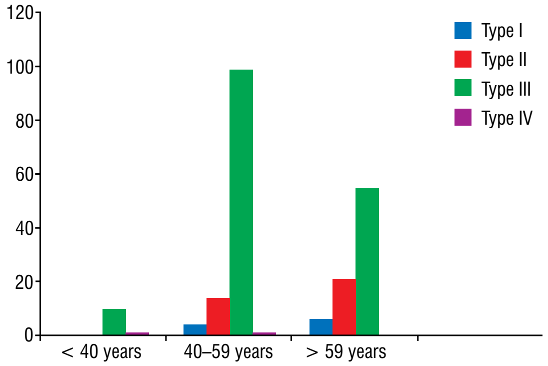

Figure 3. Distribution of bone types by age.

Patients were divided into three groups as < 40, 40–59 and > 59 according to age. Type I and II were most frequently > 59 years, type III was the 40–59 age. There was a significant relationship between the bone type and age ($p = 0.019$; Fig. 3).

The maximum bone height in male and female ranged from 18.65 to 37.32 mm and from 13.29 to 32.92 mm, respectively. The maximum bone width in male and female ranged from 9.33 to 16.31 mm and 8.60 to 18.47 mm, respectively. The bone height and width in male was significantly greater than in female ($p < 0.05$; Table 2). The bone height in dentate patients was significantly greater than in edentulous patients ($p < 0.05$; Table 2).

Type I and type IV concavity depth were 2.09 ± ± 0.34 mm and 4.02 ± 1.28 mm, respectively. In type I, the lingual slope angle was 70.59 ± 4.10° and the lingual concavity angle was 76.5 ± 3.69°. In type II, the lingual slope angle was 66.02 ± 6.58°.

DISCUSSION

The objective of this study is to explain the size and morphology of the mandible in order to guide the surgical interventions by using CBCT data of 106 patients. The interforaminal region is considered as a safe region for placing a dental implant in the mandible. However there are important neurovascular structures and blood vessels, considered to be 1–2 mm in diameter in the region. From these vessels, approximately half a litre of blood can be drained in 30 min [5]. Severe postoperative complications were also reported for this region [6, 9, 28, 34, 39].

Although the life-threatening complications were not frequently seen, they should be taken into consideration before the surgical interventions planned for this region [5, 6, 8, 9, 21, 24, 34]. Therefore in surgical procedures such as implant placement, the surgeon should have extensive knowledge of the shape and size of the bone.

The panoramic radiography can be utilized for the preliminary examination in order to obtain information about the bone height and, to a certain extent, the horizontal distance. However, the two-dimensional information provided has specific disadvantages such as distortion and magnification in images [5, 6, 8, 9, 21, 23, 24, 34, 41]. In studies comparing the computed tomography (CT) and panoramic radiography, the bone height was statistically significantly greater in panoramic radiography [2, 13, 20, 38]. These studies emphasize the importance of three-dimensional imaging methods in accurately measuring

Table 2. Measurements of mandibular dimension and lingual-buccal concavity

	Maximum bone width [mm]	Maximum bone height [mm]	Lingual slope angle [°]	Lingual concavity angle [°]	Concavity depth [mm]
Type I	11.2 ± 1.55	25.6 ± 3.49	70.59 ± 4.10	76.5 ± 3.69	2.09 ± 0.34
Type II	13.6 ± 1.42	23.5 ± 4.74	66.02 ± 6.58		
Type III	12 ± 1.57	27.3 ± 3.98			
Type IV	17.19 ± 1.28	31.89 ± 0.37			4.02 ± 1.28
Female	11.72 ± 1.57	26.02 ± 3.77	67.26 ± 7.29	75.98 ± 3.19	2.86 ± 0.47
Male	12.99 ± 1.70	28.19 ± 4.86	66.54 ± 4.75	81.9	6.61 ± 1.81
Dentate	12.06 ± 1.79	28.85 ± 3.40	70.36 ± 3.8	77.88 ± 3.43	3.82 ± 1.77
Edentulous	12.59 ± 1.60	23.86 ± 4.05	65.37 ± 6.29	73.53 ± 0.5	2.54 ± 0.14

the vertical dimension. In many studies, CT or CBCT evaluation has been suggested before implant placement in the interforaminal region [24, 27, 36]. Also in a study comparing CT and CBCT, reported that the error rate in CT (6.6%, 8.8%) was higher than CBCT (2.3%, 4.7%) [37]. Therefore, evaluation with CBCT can be more reliable.

Quirynen et al. [33] and Watanabe et al. [41] investigated the anterior mandible using CT. Quirynen et al. [33] reported, type III was the most common (69.5%), followed type II (28.1%). They [33] stated that lingual concavity prevalence is 2.4%. Watanabe et al. [41] reported the prevalence of lingual concavity 8% and buccal concavity 74%. In this study, lingual concavity is more common (4.7%) than Quirynen et al. [33], the buccal concavity was less (0.9%) than Watanabe et al. [41].

Nickenig et al. [29] evaluated the bone morphology in the mandibular canine-1 premolar region with CBCT and found a lingual concavity in 14.4%. They [29] stated that the lingual concavity was less frequently in the edentulous mandible. In our study, Nickenig et al. [29] unlike, 70% of the patients with lingual concavity were dentate. However, in some studies declared that the dentate status and bone morphology are not related [18, 22]. The differences between the lingual and buccal concavity prevalence values reported in different studies can be explained with the racial and class differences and dentate status.

The risk of lingual perforation is high when placing the implant in case of lingual concavity (type I). Also, if a large diameter (5 mm) implants are placed where bone volume is not sufficient, the risk increases more [21, 30]. Therefore, narrow diameter implants, such as 3 mm, is recommended to prevent perforation in the lingual concavity [21, 29]. If an implant of less than 3 mm diameter is used, the implant length must be longer to increase the load resistance. However, long implants may increase the possibility of reaching the artery and most cases of haemorrhage have been reported in cases using ≥ 15 mm implant [15, 19, 25, 39]. For this reason, Givol et al. [10] suggested short implants (14 mm or less) in the mandibular canine region.

There is also a risk of lingual perforation in type II bone morphology and depends on the degree of lingual slope. In cases with buccal concavity perforation may develop while implant placement, as in lingual concavity.

Previous studies reported the prevalence of lingual concavity in the posterior mandible ranged from 32.5% to 80%, higher than the anterior region [3, 5, 14, 26, 30]. Moreover, the risk of lingual perforation also varies in anterior and posterior region. The branches of major arteries in the anterior mandible (submental and sublingual arteries) might be closer to the mouth floor. Since there are no important vital structures in the posterior (submandibular gland and lymph node), immediate severe bleeding and nerve damage are not expected there is a perforation above the mylohyoid ridge [4]. Due to this anatomical difference between the anterior and posterior mandible, the determination of lingual concavity in the anterior is more important. Already severe bleeding has been reported more frequently in the anterior region [17, 35].

Nickenig et al. [29] detected minimal bone width in lingual concavity (type I, 7.6 mm). Similarly, the minimum bone width values were observed in lingual concavity (11.2 mm). Quirynen et al. [33] and Nickenig et al. [29] reported the lowest bone height in type of bone enlarging to labiolingual direction (type III, 26.8 mm and 26.9 mm, respectively). On the contrary with these results, the minimum bone height was observed in type of bones inclined to lingual (type II, 23.5 mm).

The lingual concavity depth was reported 6 mm by Quirynen et al. [33] and 0.8 mm by Nickenig et al. [29]. In our study, this value was 2.09 mm. In cases where the depth of the concavity was more than 2 mm, a high amount of lingual perforation has been reported [29].

In Quirynen et al. [33] and Nickenig et al. [29] study, lingual concavity angle was 84.4° and 84.4°, respectively. However, the angle was lower in this study (76.5°). When the relationship of lingual concavity angle with gender is evaluated, Herranz-Aparicio et al. [14] found higher values in females (+5°); in contrast, Chan et al. [5] detected higher values in males (+3°). We measured higher values in males (+6°), similar to Chan et al. [5].

Quirynen et al. [33] reported the lingual slope angle in type II as 67.6°. Our results were very close to those reported by Quirynen et al. [33] (66.02°). The degree of slope guides the osteotomy before implant placement. Therefore in type II, the risk of perforation is related to the lingual slope angle and when the lingual slope decreases (the smaller slope angle), the risk of perforation increases [33].

CONCLUSIONS

Buccal and lingual concavity may be seen in the interforaminal area. Detecting the concavity in this region is very important to prevent the perforation occurring during the surgical interventions and the consequent neurovascular damage and infection. Considering the risks, CBCT should be used in addition to panoramic radiography in cases of lingual or buccal concavity and lingual inclination.

Conflict of interest: None declared

REFERENCES

1. Badloo K, Levi E, Downie L, et al. Mycotic pseudoaneurysm of the lingual artery: a rare complication of parapharyngeal abscess. J Paediatr Child Health. 2012; 48(11): 1045–1046, doi: 10.1111/j.1440-1754.2012.02599.x, indexed in Pubmed: 23126396.
2. Bolin A, Eliasson S, von Beetzen M, et al. Radiographic evaluation of mandibular posterior implant sites: correlation between panoramic and tomographic determinations. Clin Oral Implants Res. 1996; 7(4): 354–359, doi: 10.1034/j.1600-0501.1996.070408.x, indexed in Pubmed: 9151602.
3. Braut V, Bornstein MM, Lauber R, et al. Bone dimensions in the posterior mandible: a retrospective radiographic study using cone beam computed tomography. Part 1 — analysis of dentate sites. Int J Periodontics Restorative Dent. 2012; 32(2): 175–184, indexed in Pubmed: 22292147.
4. Chan HL, Benavides E, Yeh CY, et al. Risk assessment of lingual plate perforation in posterior mandibular region: a virtual implant placement study using cone-beam computed tomography. J Periodontol. 2011; 82(1): 129–135, doi: 10.1902/jop.2010.100313, indexed in Pubmed: 20653440.
5. Chan HL, Brooks SL, Fu JH, et al. Cross-sectional analysis of the mandibular lingual concavity using cone beam computed tomography. Clin Oral Implants Res. 2011; 22(2): 201–206, doi: 10.1111/j.1600-0501.2010.02018.x, indexed in Pubmed: 21044167.
6. Darriba M, Mendonça-Caridad J. Profuse bleeding and life-threatening airway obstruction after placement of mandibular dental implants. J Oral Maxillofacial Surg. 1997; 55(11): 1328–1330, doi: 10.1016/s0278-2391(97)90195-6.
7. Felisati G, Saibene AM, Di Pasquale D, et al. How the simplest dental implant procedure can trigger an extremely serious complication. BMJ Case Rep. 2012; 2012, doi: 10.1136/bcr-2012-007373, indexed in Pubmed: 23192578.
8. Flanagan D. Important arterial supply of the mandible, control of an arterial hemorrhage, and report of a hemorrhagic incident. J Oral Implantol. 2003; 29(4): 165–173, doi: 10.1563/1548-1336(2003)029<0165:iasotm>2.3.co;2.
9. Frenken JW, Zijderveld SA, van den Bergh JPA, et al. [Haematoma of the floor of the mouth following implant surgery]. Ned Tijdschr Tandheelkd. 2010; 117(1): 17–21, doi: 10.5177/ntvt2010.01.08146, indexed in Pubmed: 20180345.
10. Givol N, Chaushu G, Halamish-Shani T, et al. Emergency tracheostomy following life-threatening hemorrhage in the floor of the mouth during immediate implant placement in the mandibular canine region. J Periodontol. 2000; 71(12): 1893–1895, doi: 10.1902/jop.2000.71.12.1893, indexed in Pubmed: 11156047.
11. Goodacre C, Bernal G, Rungcharassaeng K, et al. Clinical complications with implants and implant prostheses. J Prosthetic Dentistry. 2003; 90(2): 121–132, doi: 10.1016/s0022-3913(03)00212-9.
12. Greenstein G, Cavallaro J, Romanos G, et al. Clinical recommendations for avoiding and managing surgical complications associated with implant dentistry: a review. J Periodontol. 2008; 79(8): 1317–1329, doi: 10.1902/jop.2008.070067, indexed in Pubmed: 18672980.
13. Hanazawa T, Sano T, Seki K, et al. Radiologic measurements of the mandible: a comparison between CT-reformatted and conventional tomographic images. Clin Oral Implants Res. 2004; 15(2): 226–232, doi: 10.1111/j.1600-0501.2004.00991.x, indexed in Pubmed: 15008935.
14. Herranz-Aparicio J, Marques J, Almendros-Marqués N, et al. Retrospective study of the bone morphology in the posterior mandibular region. Evaluation of the prevalence and the degree of lingual concavity and their possible complications. Med Oral Patol Oral Cir Bucal. 2016; 21(6): e731–e736, doi: 10.4317/medoral.21256, indexed in Pubmed: 27694785.
15. Hofschneider U, Tepper G, Gahleitner A, et al. Assessment of the blood supply to the mental region for reduction of bleeding complications during implant surgery in the interforaminal region. Int J Oral Maxillofac Implants. 1999; 14(3): 379–383, indexed in Pubmed: 10379111.
16. Hwang HD, Kim JW, Kim YS, et al. Angiographic embolization for hemorrhage control after dental implantation. J Korean Assoc Oral Maxillofac Surg. 2013; 39(1): 27–30, doi: 10.5125/jkaoms.2013.39.1.27, indexed in Pubmed: 24471014.
17. Kalpidis CDR, Setayesh RM. Hemorrhaging associated with endosseous implant placement in the anterior mandible: a review of the literature. J Periodontol. 2004; 75(5): 631–645, doi: 10.1902/jop.2004.75.5.631, indexed in Pubmed: 15212344.
18. Kamburoğlu K, Acar B, Yüksel S, et al. CBCT quantitative evaluation of mandibular lingual concavities in dental implant patients. Surg Radiol Anat. 2015; 37(10): 1209–1215, doi: 10.1007/s00276-015-1493-9, indexed in Pubmed: 25994600.
19. Krenkel C, Holzner K, Poisel S. [Hematoma of the mouth floor following oral surgery and its anatomical characteristics]. Dtsch Z Mund Kiefer Gesichtschir. 1985; 9(6): 448–451, indexed in Pubmed: 3879682.
20. Lam EW, Ruprecht A, Yang J. Comparison of two-dimensional orthoradially reformatted computed tomography and panoramic radiography for dental implant treatment planning. J Prosthet Dent. 1995; 74(1): 42–46, doi: 10.1016/s0022-3913(05)80227-6, indexed in Pubmed: 7674189.
21. Leong DJM, Chan HL, Yeh CY, et al. Risk of lingual plate perforation during implant placement in the posterior mandible: a human cadaver study. Implant Dent. 2011; 20(5): 360–363, doi: 10.1097/ID.0b013e3182263555, indexed in Pubmed: 21811168.

22. Locks BJ, Claudino M, Azevedo-Alani L, et al. Evaluation of the bone anatomy of the anterior region of the mandible using cone beam computed tomography. Rev Odontol UNESP. 2018; 47(2): 69–73, doi: 10.1590/1807-2577.10517.
23. Lofthag-Hansen S, Gröndahl K, Ekestubbe A. Cone-beam CT for preoperative implant planning in the posterior mandible: visibility of anatomic landmarks. Clin Implant Dent Relat Res. 2009; 11(3): 246–255, doi: 10.1111/j.1708-8208.2008.00114.x, indexed in Pubmed: 18783419.
24. Longoni S, Sartori M, Braun M, et al. Lingual vascular canals of the mandible: the risk of bleeding complications during implant procedures. Implant Dent. 2007; 16(2): 131–138, doi: 10.1097/ID.0b013e31805009d5, indexed in Pubmed: 17563503.
25. Loukas M, Kinsella CR, Kapos T, et al. Anatomical variation in arterial supply of the mandible with special regard to implant placement. Int J Oral Maxillofac Surg. 2008; 37(4): 367–371, doi: 10.1016/j.ijom.2007.11.007, indexed in Pubmed: 18262766.
26. Magat G. Radiomorphometric analysis of edentulous posterior mandibular ridges in the first molar region: a cone-beam computed tomography study. J Periodontal Implant Sci. 2020; 50(1): 28–37, doi: 10.5051/jpis.2020.50.1.28, indexed in Pubmed: 32128271.
27. Miller RJ, Edwards WC, Boudet C, et al. Maxillofacial anatomy: the mandibular symphysis. J Oral Implantol. 2011; 37(6): 745–753, doi: 10.1563/AAID-JOI-D-10-00136, indexed in Pubmed: 20932161.
28. Mordenfeld A, Andersson L, Bergström B. Hemorrhage in the floor of the mouth during implant placement in the edentulous mandible: a case report. Int J Oral Maxillofac Implants. 1997; 12(4): 558–561, indexed in Pubmed: 9274086.
29. Nickenig HJ, Wichmann M, Eitner S, et al. Lingual concavities in the mandible: a morphological study using cross-sectional analysis determined by CBCT. J Craniomaxillofac Surg. 2015; 43(2): 254–259, doi: 10.1016/j.jcms.2014.11.018, indexed in Pubmed: 25547216.
30. Parnia F, Fard EM, Mahboub F, et al. Tomographic volume evaluation of submandibular fossa in patients requiring dental implants. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2010; 109(1): e32–e36, doi: 10.1016/j.tripleo.2009.08.035, indexed in Pubmed: 20123366.
31. Peñarrocha-Diago M, Balaguer-Martí JC, Peñarrocha-Oltra D, et al. Floor of the mouth hemorrhage subsequent to dental implant placement in the anterior mandible. Clin Cosmet Investig Dent. 2019; 11: 235–242, doi: 10.2147/CCIDE.S207120, indexed in Pubmed: 31496828.
32. Pigadas N, Simoes P, Tuffin JR. Massive sublingual haematoma following osseo-integrated implant placement in the anterior mandible. Br Dent J. 2009; 206(2): 67–68, doi: 10.1038/sj.bdj.2009.2, indexed in Pubmed: 19165260.
33. Quirynen M, Mraiwa N, van Steenberghe D, et al. Morphology and dimensions of the mandibular jaw bone in the interforaminal region in patients requiring implants in the distal areas. Clin Oral Implants Res. 2003; 14(3): 280–285, doi: 10.1034/j.1600-0501.2003.140305.x, indexed in Pubmed: 12755778.
34. Ratschew C, Czernicky W, Watzek G. Lebensbedrohliche Blutung nach Implantation im Unterkiefer. Dtsch Zahnärztl Z. 1994; 49: 65–67.
35. Romanos GE, Gupta B, Crespi R. Endosseous arteries in the anterior mandible: literature review. Int J Oral Maxillofac Implants. 2012; 27(1): 90–94, indexed in Pubmed: 22299084.
36. Sammartino G, Prados-Frutos JC, Riccitiello F, et al. The relevance of the use of radiographic planning in order to avoid complications in mandibular implantology: a retrospective study. Biomed Res Int. 2016; 2016: 8175284, doi: 10.1155/2016/8175284, indexed in Pubmed: 27294136.
37. Suomalainen A, Vehmas T, Kortesniemi M, et al. Accuracy of linear measurements using dental cone beam and conventional multislice computed tomography. Dentomaxillofac Radiol. 2008; 37(1): 10–17, doi: 10.1259/dmfr/14140281, indexed in Pubmed: 18195249.
38. Tal H, Moses O. A comparison of panoramic radiography with computed tomography in the planning of implant surgery. Dentomaxillofac Radiol. 1991; 20(1): 40–42, doi: 10.1259/dmfr.20.1.1884852, indexed in Pubmed: 1884852.
39. Ten Bruggencate CM, Krekeler G, Kraaijehagen HA, et al. Hemorrhage of the floor of the mouth resulting from lingual perforation during implant placement: a clinical report. Int J Oral Maxillofac Implants. 1993; 8: 329–334, indexed in Pubmed: 8225469.
40. Thomason JM, Feine J, Exley C, et al. Mandibular two implant-supported overdentures as the first choice standard of care for edentulous patients--the York Consensus Statement. Br Dent J. 2009; 207(4): 185–186, doi: 10.1038/sj.bdj.2009.728, indexed in Pubmed: 19696851.
41. Watanabe H, Mohammad Abdul M, Kurabayashi T, et al. Mandible size and morphology determined with CT on a premise of dental implant operation. Surg Radiol Anat. 2010; 32(4): 343–349, doi: 10.1007/s00276-009-0570-3, indexed in Pubmed: 19812884.
42. Woo BM, Al-Bustani S, Ueeck BA. Floor of mouth haemorrhage and life-threatening airway obstruction during immediate implant placement in the anterior mandible. Int J Oral Maxillofac Surg. 2006; 35(10): 961–964, doi: 10.1016/j.ijom.2006.03.020, indexed in Pubmed: 16829038.