Assesment of submandibular fossa depth using cone beam computed tomography

Konik ışınlı bilgisayarlı tomografi kullanarak submandibular fossa derinliğinin değerlendirilmesi

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SUMMARY

Aim: Due to the presence of submandibular fossa (SF), the posterior mandible is an significant anatomic region which should be taken into consideration before dental surgery. The aim of this study was to assess the SF depth in a group of patients using cone-beam computed tomography (CBCT) retrospectively.

Materials and Methods: The subjects for this retrospective study consisted of all 300 adult patients who visited the department of Oral Diagnosis and Radiology at Marmara University, and underwent a single CBCT examination. The CBCT data were picked up from the picture archiving and communications system (PACS) from the period of 2013 to 2016. Bilateral SF depths were evaluated on CBCT images. Three different SF types were categorized according amount of depth: type I; concavity depth <2 mm, type II; concavity depth between 2-3 mm and type III; concavity depth >3 mm.

Results: For the right SF depth measurements, 143 patients were found to be type I, 117 patients were type II and 38 patients were type III. For the left SF depth measurements, 150 patients were type I, 116 patients were type II and 42 patients were type III. Type I SF depth was more common in both submandibular fossa.

Conclusions: Considering the possible complications, preoperative assessment of SF depth is crucial for safe surgery in the posterior mandible. Use of CBCT enhances comprehensive evaluation of this particular anatomic region.

Keywords: Submandibular fossa, radiology, cone beam computed tomography

ÖZET

Amaç: Submandibular fossa (SF) varlığı posterior mandibular bölgeyi özellikle implant tedavisi için önemli bir anatomik bölge haline getirir. Bu nedenle, diş hekimleri tedaviden önce dikkat etmelidirler. Bu çalışmanın amacı, bir grup hastada konik ışınlı bilgisayarlı tomografi (KIBT) kullanarak SF derinliğini retrospektif olarak değerlendirmektir.

Gereç ve Yöntem: Bu çalışmada, 2013-2016 yılları arasında Marmara Üniversitesi Oral Diagnoz ve Radyoloji Anabilim Dalı'na başvuran ve KIBT çekilerek, resim arşivleme ve iletişim sistemine (PACS) eklenen 300 erişkin hastanın dataları kullanılmıştır. Bilateral SF derinliği KIBT görüntüleri üzerinden değerlendirilmiştir. Derinliğe göre üç farklı SF tipi sınıflandırılmıştır: tip I; konkavite <2 mm, tip II; 2-3 mm konkavite ve tip III; konkavite> 3 mm.

Bulgular: Sağ SF derinliği 143 hastada tip I, 117 hastada tip II ve 38 hastada tip III olarak görülmüştür. Sol SF derinliği 150 hastada tip I, 116 hastada tip II ve 42 hastada tip III olarak görülmüştür. Her iki tarafta tip I SF daha fazla oranda tespit edilmiştir.

Sonuç: Olası komplikasyonlar dikkate alındığında, SF derinliğinin preoperatif olarak değerlendirmesi güvenli bir cerrahi için önemlidir. Bu çalışma, KIBT'in bu bölgenin kapsamlı olarak değerlendirmesi için faydalı olduğunu ortaya koymuştur.

Anahtar kelimeler: Submandibular fossa, radyoloji, konik ışınlı bilgisayarlı tomografi.

INTRODUCTION

Implant treatment in modern dentistry is widely accepted, as an option for prosthodontic reconstruction, for patients to have a more aesthetic and more functional oral health. Especially, inadequate adaptation and aesthetic problems of removable dentures make implant treatment increasing day by day. The general psychosocial perception of tooth loss and the awareness of public causes the rapidly growing and aging population to focus on implant therapy.[1,2]

With proper diagnosis and treatment planning and careful surgical intervention, implant therapy progresses seamlessly and fulfills functional and aesthetic expectations after osseointegration.[3] Important considerations in implant planning include; considering the relation between the implant and vital anatomical structures such as nerves and vessels as well as the morphology and anatomical structure of bone, crest angle and size of the selected implant.[4] However, without necessary assessment, complications may occur during surgical procedures, during recovery or even after function. Depending on the severity of the damage, they may cause slight or serious problems. These complications can include important complications such as hemorrhage, nerve injury, damage to adjacent teeth, and migration of implant to anatomical landmarks.[5-8]

The submandibular fossa (SF) is a depression on the medial surface of the mandible inferior to the mylohyoid line.[9] Mandibular posterior lingual concavity, varying according to anatomic structure of SF, is a common clinical finding and the risk of perforation is high particularly when the fossa is too deep. During surgical procedures at this region, including implant surgery, extractions, periodontal surgery, osteotomies, floor of the mouth biopsies and the bone augmentation techniques have a potential complications for vascular injury and subsequent bleeding or infection. Implant surgery at this area is especially important to check the angulations and placement of the drills or implants with radiographs and clinical finding of a potential perforation in the osteotomy to avoid complications.[10,11]

A variety of imaging modalities is available for the evaluation of the amount and quality of bone in the treatment planning for dental implant settlement.[4] With panoramic images, an overview of the jaws can be viewed. They are widely used because of their availability and accessibility with low costs and are usually used for evaluation of the first assessment of the implant area.[12,13] However, there are limitations of panoramic radiography that include the absence of visualization of the bucco-lingual ridge design and the visual decrement of cortical plates or variable concavities. On the other hand, there is a variable magnification of the images in panoramic radiographs.[14]

Computed tomography (CT), in the past, and recently, cone-beam computed tomography (CBCT), seem to be the most proper presurgical radiographic evaluation methods for the prevention of complications.[4] CBCT provides cross-sectional images and is relatively an affordable instrument with less radiation when compared to CT scan.[15] CBCT makes it possible for the clinician to interpret the bucco-lingual dimensions through multi-planar reconstructions.[2]

Considering the possible variations of the SF anatomy and complications, use of CBCT for assessment of this anatomical region is an important procedure before dental surgery. The aim of this study was to analyze the prevalence and the extent of lingual concavity in the SF area by using CBCT.

MATERIALS AND METHODS

Subjects for this retrospective study consist of all 300 patients who visited the department of Maxillofacial Radiology at Marmara University and CBCT images of these patients between 2013-2016 were retrieved from the PACS system. CBCT imaging was performed with Planmeca Promax 3D Mid (Planmeca Oy, Helsinki, Finland) and assessment of CBCT was performed directly on monitor screen (Monitor 23 inch Acer 1920x1080 pixel HP Reconstruction PC). The purpose of CBCT scans were for dental implant surgery purposes. Patients with systemic diseases influencing growth and development, history of trauma and/or surgery involving the maxillofacial region, developmental anomalies/pathologies affecting the maxillofacial region, malignancy and fibroosseous lesions were excluded from the study. The study was carried out according to the recommendations of the Helsinki declaration and the written informed consent was signed by the patients before CBCT scans.

SF depth assessment has been done according to literatüre.[11,16] The region immediately distal to the border of the mental foramen and extending to the third molar area corresponds to the SF region and was selected for measurements from cross-sectional images. All the measurements were carried out by three oral and maxillofacial radiologist. The deepest part of the SF was determined and used for measurements in millimeters. A line was placed on the most prominent superior and inferior points of the lingual concavity of the mandible, and a second line was then drawn from the deepest point of the concavity perpendicular to the first line. Classification of bone morphology at SF area was sorted into three categories; Type I, with a lingual concavity less than 2 mm (Figure 1); type II (Figure 2), with a 2- to 3-mm concavity, and type III (Figure 3) with a concavity more than 3 mm. The data obtained were recorded according to age and sex.

Statistical analysis

The data were analysed with IBM Statistical Package for Social Sciences (SPSS) for Windows 15.0 (SPSS Inc, Chicago, IL). Descriptive statistical methods (mean, SD, and frequency) were used for evaluation of the data. Chi-square test, Fisher Freeman Halton test and Fisher's Exact test were used to compare qualitative data. Values of $p<0.05$ were interpreted as significant.

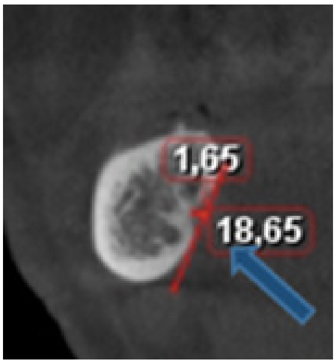

Figure 1. Type I SF depth

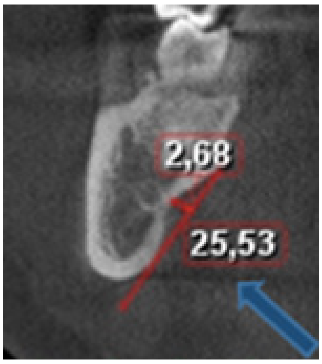

Figure 2. Type II SF depth

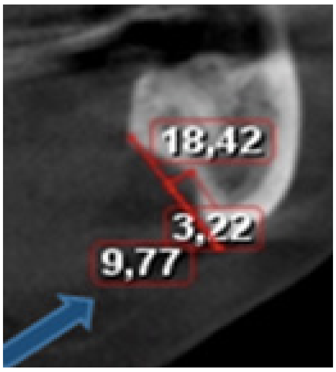

Figure 3. Type III SF depth

RESULTS

The study was carried out with a total of 300 patients aged between 15 and 80, of which 142 (47.3%) were females and 158 (52.7%) were males. The mean age of the patients was 42.49 ± 14.03. Twenty-three percent of patients were between 35 and 44 years, 22.7% over 55 years, 22% between 45 and 54 years, 19.3% between 25 and 34 years, and 13% between 15 and 24 years respectively. Of the right SF of patients, 47.7% were Type 1, 39% were Type 2 and 13.3% were Type 3. 46.7% of the left SF was Type 1, 39% was Type 2 and 14.3% was Type 3 (Table 1).

Table 1: Distribution of age, gender and types of SF.

		n	%
Age	15-24	39	13
	25-34	58	19.3
	35-44	69	23
	45-54	66	22
	Above 55	68	22.7
Gender	Female	142	47.3
	Male	158	52.7
Right SF	Type 1	143	47.7
	Type 2	117	39
	Type 3	40	13.3
Left SF	Type 1	140	46.7
	Type 2	117	39
	Type 3	43	14.3

There was no statistically significant difference in the distribution of right and left submandibular type ratios according to age groups ($p>0.05$) (Table 2).

The incidence of right SF depth Type 1 (57.7%) of females was statistically significantly higher than right SF depth Type of males 1 (38.6%) (p: 0.001; $p<0.05$). The incidence of left SF depth Type 1 (54.9%) of females was statistically significantly higher than left SF depth Type 1 of males 1 (39.2%) (p: 0.001; $p<0.05$) (Table 3).

Table 2: Evaluation of types of SF according to age.

		Age					*p*
		15-24	25-34	35-44	45-54	Above 55	
		n (%)	n (%)	n (%)	n (%)	n (%)	
Right SF	Type 1	22 (56.4%)	29 (50%)	29 (42%)	26 (39.4%)	37 (54.4%)	[1]0,168
	Type 2	14 (35.9%)	19 (32.8%)	32 (46.4%)	33 (50%)	19 (27.9%)	
	Type 3	3 (7.7%)	10 (17.2%)	8 (11.6%)	7 (10.6%)	12 (17.6%)	
Left SF	Type 1	20 (51.3%)	22 (37.9%)	36 (52.2%)	30 (45.5%)	32 (47.1%)	[1]0,530
	Type 2	16 (41%)	29 (50%)	24 (34.8%)	25 (37.9%)	23 (33.8%)	
	Type 3	3 (7.7%)	7 (12.1%)	9 (13%)	11 (16.7%)	13 (19.1%)	

*[1]Chi Square Test [2]Fisher Freeman Halton Test *p<0.05*

Table 3: Evaluation of types of SF according to gender.

		Gender		*p*
		Female	Male	
		n (%)	n (%)	
Right SF	Type 1	82 (57.7%)	61 (38.6%)	[1]0.001*
	Type 2	52 (36.6%)	65 (41.1%)	
	Type 3	8 (5.6%)	32 (20.3%)	
Left SF	Type 1	78 (54.9%)	62 (39.2%)	[1]0.001*
	Type 2	55 (38,7%)	62 (39.2%)	
	Type 3	9 (6.3%)	34 (21.5%)	

*[1]Chi Square Test [2]Fisher's Exact Test *p<0.05*

DISCUSSION

Understanding and predominating the anatomy ensures the surgeon confidence to manipulate tissues definitely in order to restore form, function, health, and esthetics.[17] Apart from the nerve damage during implant placement, various studies reported occurrence of life threatening bleeding after the placement of dental implants in edentulous mandibles.[18-21] This may be due to the angulation of the lingual cortical plate in the premolar-molar region and the existence of a lingual concavity in particular conditions.[17]

The blood supply of the premolar–molar region that originates from and represent a potential danger for severe bleedings in implant surgery are submental artery and mylohyoid artery. Submental artery leaves the facial artery at the site of the submandibular gland and runs anteriorly on the surface of the mylohyoid muscle and inferior to the body of the mandible. The mylohyoid artery runs on the medial surface of the mandible in the mylohyoid groove and continues supplying the mylohyoid muscle. The mylohyoid branch of the inferior alveolar artery can be injured after perforating the mandibular lingual cortex in the molar region.[22,23]

At the present time, dental implant placement procedures are performed not only by oral surgeons but also increasingly by practitioners. From that perspective, to avoid unexpected complications and to increase the success rate, accurate radiographic evaluation is a crucial aspect. Digital or conventional a number of imaging modalities have been used to evaluate bone quality, quantity, and location of anatomic structures. Although, panoramic radiographies are the most commonly used and relied imaging modality by clinicians and their relatively low cost and widespread availability, there are inherent fundamental limitations due to its modality such as superimpositions, magnifications, distortions and low image quality.[24,25] Furthermore¸ because of the difficulty of interpret anatomical structures on two-dimensional plane, development of three-dimensional imaging techniques has accelerated. In order to overcome of those above mentioned disadvantages and to obtain more accurate images of anatomical structures, a new era opened by the invention of CBCT. CBCT technology allows clinicians precious information not only about anatomical structures, but also about the pathologies or findings outside the primary area of interest. Owing to widespread use of CBCT, it became difficult to misdiagnose anatomic variants, developmental anomalies or artifacts as pathological entities.[26]

There are different studies assessing the lingual concavity on SF area. Watanabe[23] classified the shapes of the mandibles into three types (A, B, and C) as round on the buccal side and concave on the lingual side, concave on the buccal side and round on the lingual side, round shaped on both sides respectively and found the percentage of lingual concavity betweeen 36-39% on CT scans. Sumer[16] evaluated the depth of SF in 86 patients using CT and panoramic images in 2015 and found 55.2% of the cases as <2mm, 28.5% in 2-3mm, 16.3% >3mm. Yıldız[27] evaluated the bone morphology of 78 adult human mandibles on CT scans and found SF depth as 35% <2mm, 35% 2-3mm, 36.5% >3mm. In our study, 47.7% of the right SF were Type 1, 39% were Type 2 and 13.3% were Type 3. 46.7% of the left SF is Type, 39% is Type 2 and 14.3% is Type 3. Our study is consistent with Sumer[16] which may be due to ethnicity. Yoon[28] evaluated lingual concavity and classified alveol ridge as paralel, concave, or convex in 104 patients. They found no significant difference detected for gender with an increase in prevalence observed at age 63 years and older. In our study, right and left SF depth Type 1 (57.7%) of females was higher than that of males (38.6%) (p:0.001; $p<0.05$) This significant finding was may be related to hormonal influences. The differences between our study and Yoon[28] may be based on different classification used or the presence of teeth.

SF depth was found to be 20% <2mm, 52% 2-3mm, 28% >3mm in 100 cases that with CT in 2009 by Parnia.[11] In their study, they investigated no significant differences among age categories. In our study, although no significant difference was observed between age groups, the ratio of type 3 submandibular concavity depth increased with age. Type II and especially type III categories would increase the potential risk of lingual perforation and complications during implant insertion. Leong[17] suggested that in the presence of significant lingual concavity in the posterior mandible, a smaller regular diameter implant with a tapered design should be considered to avoid a potential fatal damage of vital structures.

CONCLUSIONS

Lingual concavity size may vary according to age, gender, concavity position and SF anatomy. Type I SF was found to be the most common in our study group. A particular CBCT scan investigation of concavity morphology should be done before implant surgery for preventing possible complications.

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