ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

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Retrospective Evaluation of Stafne Bone Cavities with Cone Beam Computed Tomography

Konik Işınlı Bilgisayarlı Tomografi ile Stafne Kemik Kavitelerinin Retrospektif Değerlendirilmesi

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ABSTRACT Objective: The aim of this study is to evaluate demographic and radiographic characteristics of Stafne bone cavity (SBC) in detail in a large group of cases. **Material and Methods:** 6,758 cone-beam computed tomography (CBCT) images taken in İstanbul University Faculty of Dentistry, Oral and Maxillofacial Radiology Department between 2015-2018 were included in the study. Cases were evaluated and recorded with regard to age, gender, localization of the lesion, location (right-left), dimensions of the lesion (depth, height ,and width), cortical types of the lesion and newly modified cortical types, edge border types of the lesion and margin types. **Results:** Twenty seven cases (0.39%) of SBC were detected among 6,758 images. The average age of the patients with SBC was 48.56±10.577 (minimum 26, maximum 70). Among 27 patients with SBC, 23 (85.2%) were male and 4 (14.8%) were female. A statistically significant positive correlation was found between cases' the depth, height and width (p=0.000; r>0.7). A statistically significant positive correlation was found between the size of the cases and the cavity types (p=0.000; r>0.4). There was no statistically significant correlation between the mandibular canal relationship and all other parameters (p>0.05). **Conclusion:** Diagnosis and follow-up of SBC cases are often carried out by CBCT images; therefore, it is crucial to know the radiographic features and current classifications in detail.

Keywords: Cone beam computed tomography; salivary glands; mandible

ÖZET Amaç: Bu çalışmanın amacı, Stafne kemik kavitesinin (SKK) demografik ve radyografik özelliklerini geniş bir vaka grubunda ayrıntılı olarak değerlendirmektir. **Gereç ve Yöntemler:** İstanbul Üniversitesi Diş Hekimliği Fakültesi Ağız, Diş ve Çene Radyolojisi Ana Bilim Dalında 2015-2018 yılları arasında çekilen 6.758 konik ışınlı bilgisayarlı tomografi (KIBT) görüntüsü çalışmaya dâhil edildi. Olgular yaş, cinsiyet, lezyonun lokalizasyonu, yerleşim yeri (sağ-sol), lezyon boyutları (derinlik, yükseklik ve genişlik), lezyonun kortikal tipleri ve yeni modifiye kortikal tipleri, kenar sınırları ve marjin tipleri açısından değerlendirildi. **Bulgular:** 6.758 görüntü arasında 27 (%0,39) vakada SKK tespit edildi. SKK'lı hastaların yaş ortalaması 48,56±10,577 (minimum 26, maksimum 70). SKK'lı 27 hastanın 23'ü (%85,2) erkek, 4'ü (%14,8) kadın olarak tespit edildi. Olguların derinlik, yükseklik ve genişlikleri arasında istatistiksel olarak anlamlı pozitif korelasyon bulundu (p=0,000; r>0,7). Vakaların büyüklükleri ile kavite tipleri arasında istatistiksel olarak anlamlı pozitif korelasyon bulundu (p=0,000; r>0,4). Mandibular kanal ilişkisi ile diğer tüm parametreler arasında istatistiksel olarak anlamlı bir ilişki yoktu (p>0,05). **Sonuç:** SKK vakalarının tanı ve takibi sıklıkla KIBT görüntüleri ile yapılmaktadır, bu nedenle radyografik özelliklerin ve güncel sınıflandırmaların detaylı olarak bilinmesi çok önemlidir.

Anahtar Kelimeler: Konik ışınlı bilgisayarlı tomografi; tükürük bezleri; mandibula

Stafne bone cavities (SBCs) are; well-defined radiolucent defect areas in the mandibular molar region, below the inferior alveolar canal. SBCs are generally observed unilaterally and asymptomatic in round and oval forms. SBCs are also known as lingual mandibular bone depression, developmental salivary gland defect, idiopathic bone cavity, and latent bone cyst.[1] In 1942, Edward Stafne first reported 35 asymptomatic, unilateral radiolucent areas in the mandible posterior region.[2] The anterior variant, located in the mandibular canine-premolar region, was first reported by Richard and Ziskind in 1957.[2]

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Although its etiology is not known precisely, there are various theories, including mandibular bone atrophy due to the pressure of the dorsal part of the submandibular gland, displacement of the sublingual gland, and functional changes in the bone.[3] However, the generally accepted theory has been the salivary gland pressures on the mandibular lingual cortex. Cases in the posterior region of the mandible are associated with the submandibular gland, cases in the anterior region of the mandible are associated with the sublingual gland, and lesions in the mandible ramus are associated with the parotid gland.[4]

SBCs are generally asymptomatic and encountered in routine radiographic evaluation. It is frequently seen in males and between 6th-7th decades of life.[3] Radiography shows unilocular, in round or ovoid form, well-defined radiolucent lesions in various sizes. SBCs are rarely seen with an irregular border, bilaterally or multilocular.[5,6]

Plain radiographs or panoramic radiographs are often used for diagnosis to this phenomenon. Advanced imaging techniques such as computed tomography (CT), cone-beam CT (CBCT), and magnetic resonance imaging (MRI) may be required for definitive diagnosis in atypical cases (lobular, cortical destruction, multiple, etc.).[6] Although CT imaging is better in soft tissue evaluation, radiation doses compared to CBCT are the disadvantage of this method. MRI successfully evaluates the tissue in the cavity but being costly to get one constitutes a significant disadvantage. Although CBCT is successful in low radiation dose and characterization of the cavity, it is recommended to be evaluated together with MRI in suspicious cases.[7]

Only 1 or 2 parameters were evaluated for SBCs in the literature and few with using CBCT imaging techniques. The study aims to retrospectively evaluate the demographic and radiographic characteristics of SBC in detail (using all parameters determined as evaluation criteria in the literature) in a large group of cases using CBCT.

MATERIAL AND METHODS

This study was conducted by the principles of the Declaration of Helsinki 2008. Approval for this study was obtained from the İstanbul University, Faculty of Dentistry, Clinical Research Ethics Committee (date: July 31, 2019; no: 437). In our Department of Oral and Maxillofacial Radiology Clinic, the patient information and consent form was signed by each patient prior to every radiological examination. This form is used to give consent to the university for the anonymous use of medical images for scientific research.

6,758 CBCT images taken in İstanbul University Faculty of Dentistry, Oral and Maxillofacial Radiology Department between 2015-2018 were included in the study. The images were obtained with Scanora® 3Dx CBCT device (Soredex, Tuusula, Finland), and the images were analyzed by using OnDemand 3D™ software (Cybermed, California, USA) on an Advantech KT-R240FEE Medical LCD Monitor by Kostec (Gangwon, South Korea) monitor. The minimum field of view size was 50x50 mm, and the maximum field of view size was 240x165 mm. According to the selected field of view size, voxel size takes value in the range of 0.1-0.5 mm^3 and the section thickness in the range of 0.1-0.3 mm. The usage parameters of the device were 60-90 kV, 4-10 mA, target angle 15 degrees, and focal spot 0.5 mm. The imaging time was 18-24 seconds, and the effective exposure time was 2.4-6 seconds. The image receptor was a flat panel system.

CBCT images were examined by one expert with 10 years of professional experience and 2 research assistants with 4 and 6 years of professional experience. Images with any pathology in the relevant area and images that do not include the mandible were not included in the study. All detected SBC images were evaluated jointly to define their classification types. Radiological characteristics of the cases were determined with a joint decision.

SBCs have been classified radiographically according to their localization, relation with buccal cortical bone, and cortical defect edges. Regarding localization, SBC has been examined in 3 classes. Posterior type: Located in the inferior of the mandibular canal and between the first molar tooth and angulus mandible. Anterior type: Located between incisive and premolar teeth. Ramus type: Lo-

cated in the buccal or lingual of the ramus. The most common type is the posterior lingual type, whereas the rarest type is the ramus type.[8]

SBC has been examined in 3 classes regarding its relation with the buccal cortical bone. Type I: SBC does not reach the buccal cortex. Type II: SBC reaches the buccal cortex, but no change is observed in the cortex. Type III: SBC reaches the buccal cortex, and expansion is observed.[9]

In addition to these classifications, a new one has been introduced that rearranges classification according to cortical perforation. Type I: Cavity depth is limited to the medullary portion of the mandible. Type II: Cavity depth reaches the buccal cortex of the mandible but does not cause its expansion. Type IIa: Cavity depth reaches the buccal cortex of the mandible and causes its erosion. Type IIb: Cavity depth reaches the buccal cortex of the mandible and causes its perforation. Type III: Cavity depth reaches the buccal cortex of the mandible and causes its expansion. Type IV: Cavity depth reaches the buccal cortex and causes its expansion and perforation.[10]

Another classification has been suggested according to cortical defect edges: broad type, narrow type, smooth margin, and irregular margin.[11]

Cases were evaluated and recorded concerning age, gender, localization of the lesion, location (right-left), dimensions of the lesion (depth, height, and width), cortical types of the lesion, and newly modified cortical types, edge border types of the lesion and margin types (Figure 1, Figure 2, Figure 3).

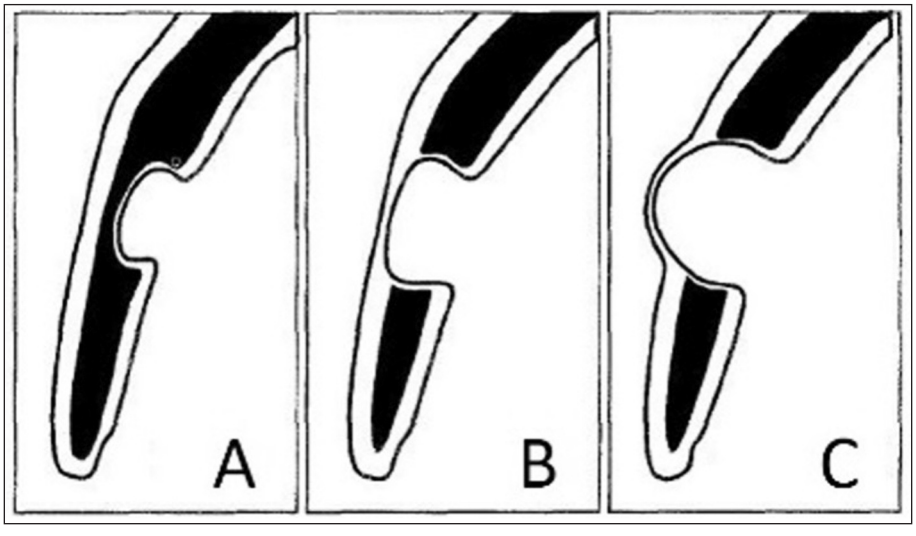

FIGURE 1: Cortical type of Stafne bone cavity **A.** Type I, **B.** Type II, **C.** Type III.[9]

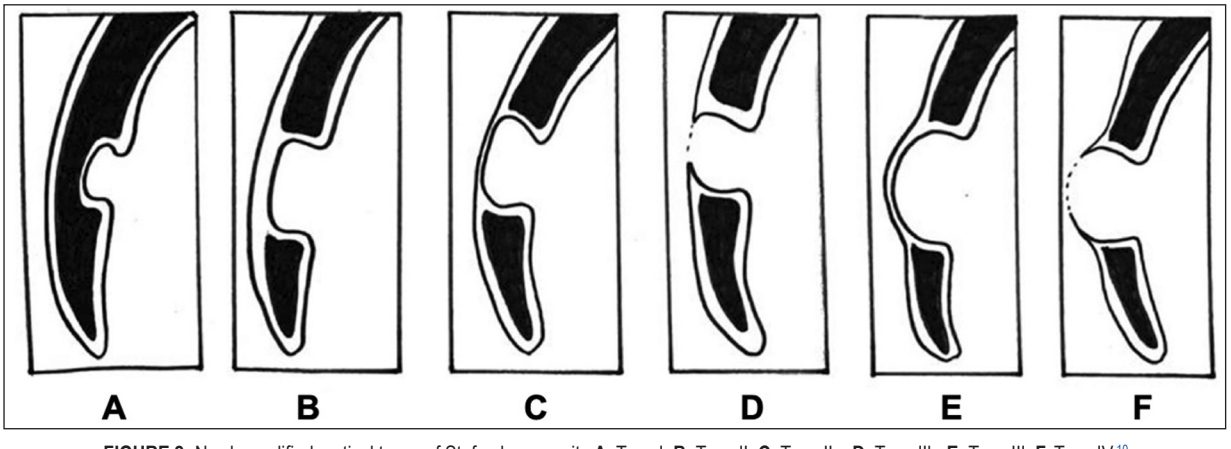

FIGURE 2: Newly modified cortical types of Stafne bone cavity **A.** Type I, **B.** Type II, **C.** Type IIa, **D.** Type IIb, **E.** Type III, **F.** Type IV.[10]

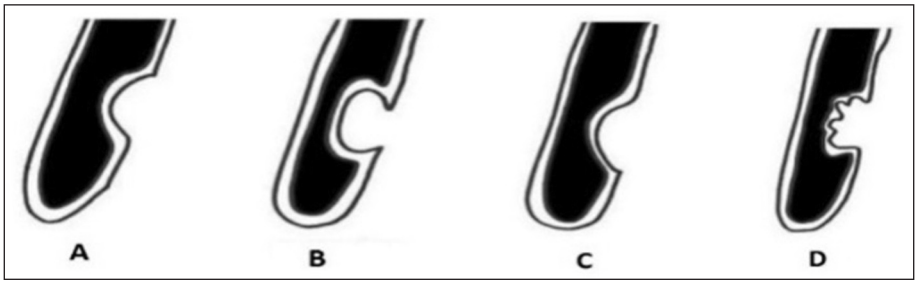

FIGURE 3: Edge border types and margin types of Stafne bone cavity **A.** Broad type, **B.** Narrow type, **C.** Smooth margin, **D.** Irregular margin.[11]

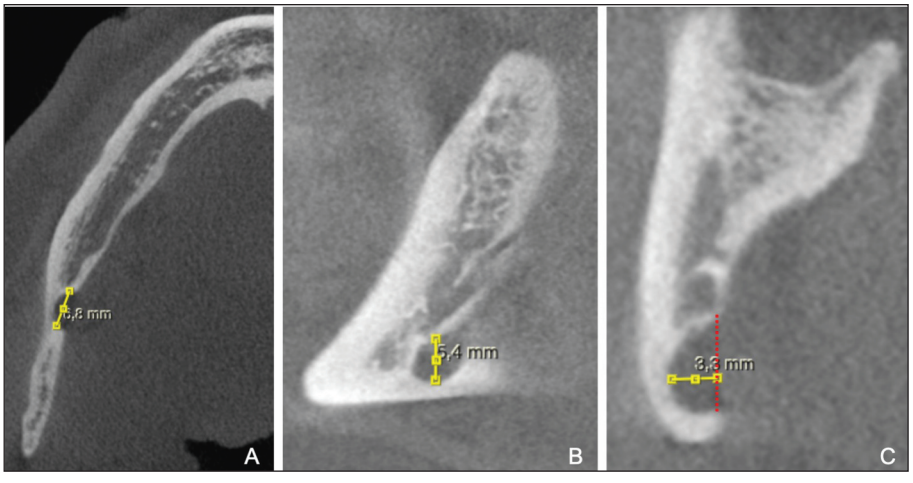

FIGURE 4: Determination of lesion dimensions in 3 orthogonal planes on cone-beam computed tomography images. **A.** Measuring the width of the lesion on the axial section, **B.** Measuring the heigth of the lesion on the sagittal section, **C.** Measuring the depth of the lesion on the coronal section.

Lesions were evaluated from 3 orthogonal sections (axial, coronal, sagittal), and size measurements were made from the largest area. The height of the lesion was determined on the sagittal section. The depth of the lesion was ascertained on the coronal section. The width of the lesion was evaluated on the axial section. In the part where the soft tissue is located, the value between the line passing through the edge cortical points and the points in the broadest area was accepted (Figure 4).

Statistical analysis was performed using IBM SPSS Statistics V.25 (New York, USA). Shapiro-Wilk test, Mann-Whitney U test, and Spearman correlation test were used and $p<0.05$ were considered as statistically significant.

RESULTS

Twenty seven cases (0.39%) of SBC were detected among 6,758 images. The average age of the patients with SBC was 48.56±10.58 (minimum 26, maximum 70). Among 27 patients with SBC, 23 (85.2%) were male and, 4 (14.8%) were female. The average age of men with SBC was 47.87±10.29 (minimum 26, maximum 65), whereas the average age of women with SBC was 52.50±13.00 (minimum 40, maximum 70).

Detailed demographic and radiographic characteristics of all cases are presented in Table 1. Only 1 anterior SBC case was detected among 27 cases (Figure 5).

As a result of statistical evaluation, no significant difference was found between lesion sizes and localization, cortical and edge types. Comparing cortical types in terms of dimensions, a statistically significant difference was observed between the types ($p<0.05$) (Table 2). While examining the data, it was found statistically significant that Type III had higher values on average than all other types in all dimensions. When the edge types were compared in terms of dimensions, no statistically significant difference was observed ($p>0.05$) (Table 3). While the dimen-

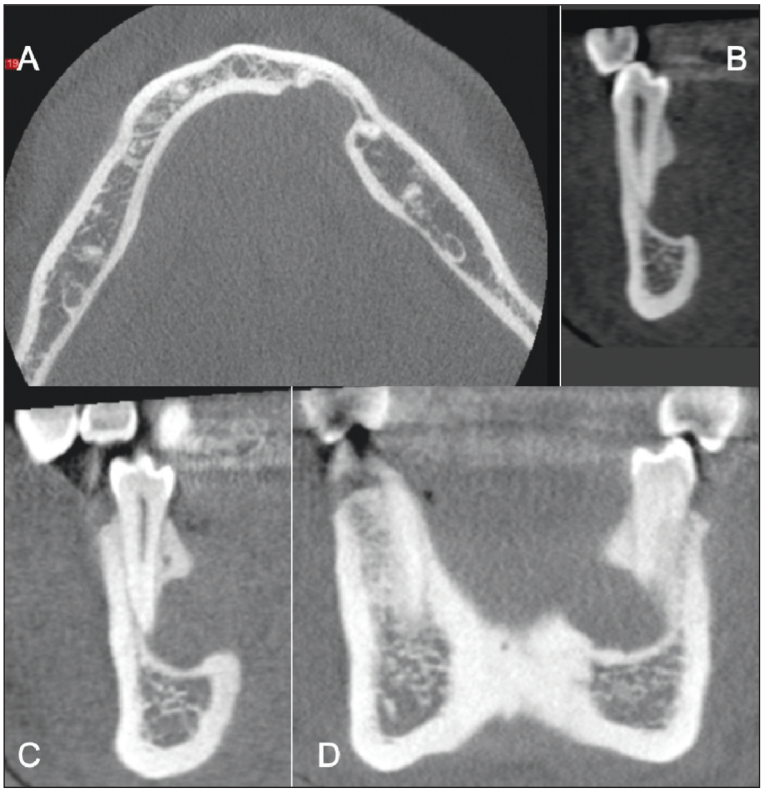

FIGURE 5: Cone-beam computed tomography images of anterior Stafne bone cavity case located in the left premolar area. **A.** Axial section view, **B.** Cross-sectional view, **C.** Sagittal section view, **D.** Coronal section view.

sions of the cases and margin types were compared, there was only a difference between height and margin types (p=0.036), and no statistically significant difference was found between the margin types for other measures (p>0.05) (Table 4). When the dimensions of the cases and the mandibular canal relations were compared, no statistically significant difference was found between the mandibular canal relationships (p>0.05) (Table 5).

A statistically significant positive correlation was found between the depth, height and width (p=0.000; r>0.7). A statistically significant positive correlation was found between the size of the cases and the cavity types (p=0.000; r>0.4). There was no statistically significant correlation between the mandibular canal relationship and all other parameters (p>0.05).

The cases were re-evaluated according to their relationship with the cortical bone for to match the new classification criteria. It was determined that the classification of 8 cases had to be remade. It was observed that 2 cases determined as Type III according to the old classification changed to the new classification Type IV, and 6 cases determined as Type II changed to Type IIa.

DISCUSSION

SBCs are rarely seen (0.1-0.48%) and are only noticed during a routine radiographic examination.[1] This study's results of discovery chances were consistent with the data specified in the literature (0.39%). Our study stands out with a large number of cases since the presented cases in the literature have been very limited.

SBCs are mainly detected in the male population in their sixth or seventh decade of life. In the study of Philipsen et al., the probability of occurrence in men was found 6 times more often than in women.[12] In the report of Quesada-Gómez et al., 8 of the 11 SBC cases examined on panoramic radiog-

TABLE 1: Demographic and radiographic characteristics of the SBC cases.

Case	Age	Sex	Localization	Right-left	Depth	Height	Width	Cortical type	New cortical type	Edge type	Margin type	Mandibular canal
1	33	M	P	R	8.10	12.50	13.90	II	IIA	B	I	Inside
2	47	M	P	R	6.00	5.50	9.50	I	I	B	S	Contact
3	52	M	P	R	13.70	16.10	24.60	III	IV	B	I	Contact
4	36	M	P	R	6.60	14.30	21.10	II	IIB	N	I	Inferior
5	49	M	P	R	3.80	7.60	10.70	II	IIA	B	S	Inferior
6	58	M	P	L	4.90	6.80	9.20	II	IIA	N	S	Inferior
7	44	M	P	R	3.90	6.70	9.10	II	II	B	S	Contact
8	47	M	P	R	8.90	9.20	15.50	II	II	B	S	Inside
9	39	M	P	R	5.20	12.60	12.90	II	II	B	S	Inside
10	54	F	P	L	8.30	10.40	20.10	III	III	B	S	Contact
11	70	F	P	R	6.80	8.60	11.90	II	II	N	S	Contact
12	46	M	P	R	4.10	8.70	10.20	II	II	B	S	Inferior
13	65	M	P	R	4.20	5.80	9.50	I	I	B	S	Inferior
14	56	M	P	R	14.30	17.40	23.90	III	III	B	S	Contact
15	36	M	P	L	5.30	7.20	12.30	I	I	N	S	Contact
16	58	M	P	R	5.30	11.10	10.00	II	II	B	I	Inferior
17	53	M	P	L	5.80	10.30	13.10	II	IIA	B	I	Contact
18	55	M	P	L	6.70	9.40	15.50	II	II	B	S	Inferior
19	38	M	P	L	6.10	9.70	12.40	II	II	B	S	Inferior
20	26	M	A	L	6.40	10.60	13.60	I	I	B	S	Anterior
21	46	F	P	R	4.40	8.40	8.70	II	II	N	I	Inferior
22	37	M	P	R	1.90	8.60	6.10	I	I	N	S	Contact
23	55	M	P	L	4.10	6.70	7.40	II	II	B	S	Inferior
24	57	M	P	R	3.30	5.40	6.80	I	I	B	S	Inferior
25	40	F	P	L	5.30	8.70	17.40	III	IV	B	S	Contact
26	51	M	P	R	7.70	16.80	21.30	II	II	N	S	Inferior
27	63	M	P	R	2.80	7.20	7.20	II	IIA	B	S	Inferior

SBC: Stafne bone cavity; F: Female; M: Male; A: Anterior; P: Posterior; R: Right; L: Left; B: Broad type; N: Narrow type; S: Smooth marjin; I: Irregular marjin.

TABLE 2: Evaluation of the dimensions and cavity types.

Cavity type			Mean difference	p value*
Depth of SBC cases	Type I	Type II	-1.020	0.367
		Type III	-5.123	0.017
	Type II	Type I	1.020	0.367
		Type III	-4.102	0.025
	Type III	Type I	5.123	0.017
		Type II	4.102	0.025
Height of SBC cases	Type I	Type II	-2.335	0.059
		Type III	-6.196	0.017
	Type II	Type I	2.335	0.059
		Type III	-3.861	0.032
	Type III	Type I	6.196	0.017
		Type II	3.861	0.032
Width of SBC cases	Type I	Type II	-2.179	0.231
		Type III	-11.786	0.04
	Type II	Type I	2.179	0.231
		Type III	-9.607	0.001
	Type III	Type I	11.786	0.04
		Type II	9.607	0.001

*Mann-Whitney U test; SBC: Stafne bone cavity.

TABLE 3: Evaluation of the dimensions and edge types.

Edge type		Depth of SBC cases	Height of SBC cases	Width of SBC cases
Broad type	$\bar{X}$	6.315	9.580	13.165
	SD	3.110	3.261	5.139
				1
Narrow type	$\bar{X}$	5.371	10.100	2.942
	SD	1.923	3.856	6.009
	p value*	0.893	0.935	0.646

*Mann-Whitney U test; SBC: Stafne bone cavity; SD: Standard deviation.

TABLE 4: Evaluation of the margin type and dimensions of cases.

	Margin type of SBC cases	n	$\bar{X}$	SD	p value*
Depth of SBC cases	S Type	21	5.71	2.66	0.231
	I Type	6	7.31	3.36	
Height of SBC cases	S Type	21	9.02	3.23	0.046
	I Type	6	12.11	2.79	
Width of SBC cases	S Type	21	12.5	4.92	0.27
	I Type	6	15.23	6.3	

SBC: Stafne bone cavity; SD: Standard deviation. *Mann-Whitney U test.

TABLE 5: Evaluation of the mandibular canal relationship and dimensions of cases.

Mandibular canal relationship		Depth of SBC cases	Height of SBC cases	Width of SBC cases
Inside	$\bar{X}$	7.4	11.43	14.1
	SD	1.94	1.93	1.31
	Minimum	5.2	9.2	12.9
	Maximum	8.9	12.6	15.5
Contact	$\bar{X}$	7.13	9.95	14.8
	SD	3.99	3.89	6.39
	Minimum	1.9	5.5	6.1
	Maximum	14.3	17.4	24.6
Inferior	$\bar{X}$	4.92	9.06	11.53
	SD	1.46	3.32	4.86
	Minimum	2.8	5.4	6.8
	Maximum	7.7	16.8	21.3
Anterior	$\bar{X}$	6.4	10.6	13.6
	SD			
	Minimum	6.4	10.6	13.6
	Maximum	6.4	10.6	13.6
	p value*	0.2	0.397	0.362

*Kruskal-Wallis test; SBC: Stafne bone cavity; SD: Standard deviation.

raphy were men.[13] Demiralp et al. evaluated 169 CBCT images in their study. All patients were reported as male, and the mean age was 51.[4] In our study, it was frequently detected in men (85.2%) and between the ages of 26-65.

Unlike what is on the current literature, all the parameters in which SBCs were examined simultaneously in this study. In addition to the literature, it was also evaluated whether these parameters correlated. Twenty seven cases we evaluated in the study

were male patients. Most cases were located posteriorly, in the right side, and inferior to the mandibular canal. The most common classification types were; cavity Type II, broad type, and smooth margin type. The posterior type has been found more frequently in all studies, and the age range is generally between 35-75 years. Ariji et al. evaluated 16 cases with CT in their study. Type I in 6 cases, Type II in 7 cases, and Type III in 3 cases were detected.[9] There are also studies in which Type I cases are seen more frequently. Type II cases were in the majority in our study, with a higher rate.

Fourteen cases were evaluated with panoramic radiography in the report of Adisen et al. It was found that 8 of the lesions were not associated with the mandibular canal, 3 cases were in contact with the mandibular canal, and 3 cases were located on the mandibular canal.[14] In our study, 13 cases were not associated with the mandibular canal, 10 were in contact with the mandibular canal, and 3 were located on the mandibular canal. In lesions associated with the mandibular canal, it is possible to experience symptoms from the pressure exerted by the lesion.

However, a statistically significant result could not be obtained when the dimensions of the lesions and all these values (age, gender, localization, cortical type, cavity type, mandibular canal relationship) were compared. It is noteworthy that the relationship with the mandibular canal does not correlate with any parameter, although it is expected to correlate with lesion dimensions.

With modification, it is anticipated that a more comprehensive classification can be made, and more information about SBC characterization will be gained. It is tought to help to evaluate and to create a follow up protocole on the lesions.[10] When we revised our study considering the classification modified, it was found that approximately one-third of the cases changed. This has made it clear that an update is required in the classification. While evaluating SBC cases, we argue that instead of single specific parameter, the examination should be done by considering all parameters, as we did in this study. It was thought that when the three-dimensional images of more cases are evaluated, revisions can be made according to new examination needs. It is predicted that in future studies to be conducted on cases with both CBCT and MRI images, the effect of the tissue type in the lesion on these classifications can be evaluated, and it will help in the follow-up and in determining the need for surgical procedure.

During the radiographic evaluation of SBC, the following differential diagnoses should be considered: benign salivary gland tumors, hemangioma, myxoma, central giant cell lesion, simple bone cavity, ameloblastoma, multiple myeloma, fibro-osseous lesions, and metastasis.[14,15] Treatment of SBC is usually followed up by panoramic radiography or CBCT, and its dimensions in control radiographs should be compared with the previous dimensions. Surgical procedures such as biopsy and enucleation are performed only for diagnostic reasons.[16] The use of various parameters in the classification of the lesion provides better characterization of the lesion but also helps to determine the changes in the lesion more efficiently during the follow-up phase and to determine the need for a surgical procedure.[10]

CONCLUSION

In this study, in which we examined 6,758 CBCTs, we detected only 27 SBC cases. These cases were examined in detail and determined that the majority of the cases were male. Most of the lesions were located in the posterior region, on the right, and under the mandibular canal. Most lesions were found to have Type II cavity type, broad type, and smooth margin. When all parameters were compared with each other, a statistical difference was found only between lesion size and cortical type, height and margin type.

Learning the characteristic of SBC in CBCT images is essential for diagnosis, follow-up, and differential diagnosis of the lesion, thus preventing unnecessary surgical procedures. As more lesions are evaluated, it will be possible to identify different characteristics of SBC and new types of classification can be added. In this respect, the number of people in the CBCT scanned population and the high number of detected cases will provide a more accurate classification in future studies.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Sedef Ayşe Taşyapan, Hülya Çakır Karabaş;* ***Design:*** *Sedef Ayşe Taşyapan, Hülya Çakır Karabaş;* ***Control/Supervision:*** *İlknur Özcan;* ***Data Collection and/or Processing:*** *Sedef Ayşe Taşyapan, Hülya Çakır Karabaş, Beliz Güray, Murat Mert Atapek;* ***Analysis and/or Interpretation:*** *Sedef Ayşe Taşyapan, Hülya Çakır Karabaş, Beliz Güray, Murat Mert Atapek, İlknur Özcan;* ***Literature Review:*** *Sedef Ayşe Taşyapan, Hülya Çakır Karabaş;* ***Writing the Article:*** *Sedef Ayşe Taşyapan, Hülya Çakır Karabaş;* ***Critical Review:*** *Sedef Ayşe Taşyapan, Hülya Çakır Karabaş;* ***References and Fundings:*** *İlknur Özcan;* ***Materials:****İlknur Özcan.*

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