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Incidental Findings in Cone-Beam Computed Tomographic Images: Calcifications in Head and Neck Region

SUMMARY

Background/Aim: *The use of CBCT in dentistry has been increasing popularity nowadays. CBCT images provide valuable information from anatomic structures and pathologies. Images obtained with CBCT allow for more appropriate treatment planning. The purpose of this study was to assess the calcifications which were found incidentally on CBCT images and to reveal the frequency and characteristics.* ***Material and Methods***: *A total of 691 CBCT images which obtained from the patients were assessed. Demographic data and calcifications which were found out of primarily interest area were noted. The incidental findings were categorized and analyzed using descriptive statistics.* ***Results:*** *945 calcifications were discovered on 318(46.02%) of the 691 patients' images. 373(53.98%) scans showed no calcificated findings. The age range of patients was from 5 to 84 years. The most common calcification was tonsillolith (86.03%), followed by stylohyoid calcifications (6.24%), antrolith and subdermal calcifications (2.33%).* ***Conclusion:*** *Calcified lesions in head and neck region were commonly seen in CBCT images. Although the most of the calcifications are asymptomatic and require no treatment but correct identification of these findings will reduce unnecessary further diagnostic assessments and will provide more appropriate treatment plans. It will also provide the ability comprehensively evaluation of underlying diseases and practitioners will have life-saving information by early diagnosis.*

Key words: CBCT, İncidental Findings, Calcifications, Radiology

Ali Altındağ[1], Hakan Avsever[2], Oguz Borahan[3], Mesut Akyol[4], Kaan Orhan[1]

[1] Ankara Universitty, Faculty of Dentistry
Department of Dentomaxillofacial Radiology
Ankara, Turkey
[2] Gulhane Training&Reserach Hospital
Health Sciences University, Dentistry Center
Department of Dentomaxillofacial Radiology
Ankara, Turkey
[3] Marmara University
Department of Dentomaxillofacial Radiology
Istanbul, Turkey
[4] Yildirim Beyazit University
Department of Biostatistics, Ankara, Turkey

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Introduction

Soft tissue calcifications in the maxillofacial area are uncommon, and generally correspond to radiographic findings in routine examinations such as panoramic radiographs. Calcification of soft tissue structures in the head and neck can present as physiologic or pathologic mineralization. Pathologic mineralization is more likely to occur in the articular cartilage, ligaments, and glandular and vascular tissues and is usually associated with chronic inflammation or scarring[1]. There are 3 types of pathologic calcifications: 1) dystrophic calcification, which occurs in degenerating and dead tissues; 2) metastatic calcification, in which calcium and other salts are deposited in previously undamaged tissue as a result of excess salts in the circulating blood; and 3) calcinosis, which is calcification in or under the skin. However many of the structures in the head and neck region are in close proximity to one another which makes these calcifications localization and identification difficult[2]. Such as panoramic radiographs, conventionally radiographic images are inherently planar and 2-dimensional (2D), making localization and diagnosis problematic. Conventional 2D imaging is likely to result in relatively low diagnostic success, especially in cases in which relatively small calcifications are present or are superimposed on anatomic structures[3]. In such cases, a second radiologic 2D plane must be obtained. However, the combination of 2 conventional 2D imaging strategies could increase the radiation exposure to a level similar to that of low-dose cone beam computed tomography (CBCT) imaging[4].

CBCT introduced in 1998, is increasingly used for 3-dimensional imaging in maxillofacial radiology[5]. Available CBCT scanners generate image volumes of a field of view from (height X width) 4 X 4 cm to 23 X 17 cm. Spatial resolution of isotropic voxel size of available scanners ranges from 0.08 to 0.4 mm[1-4]. Larger scans provide a comprehensive radiologic view of the maxillofacial skeleton and partly of the soft tissue therein.

CBCT imaging has been applied in implantology, orthodontics, maxillofacial surgery and in the assessment of dentoalveolar pathology[6,7]. With the increasing use of CBCT imaging in dentistry, the incidental discovery of soft fissue calcifications is likely to increase. In addition, CBCT imaging provides images in the third dimension, which facilitates precise localization. The clinician should have a solid foundation in the radiographic presentation of the calcification condition as it relates to the various structures, particularly on CBCT images. CBCT imaging is an excellent diagnostic tool to determine the size, location, and shape of calcifications[1-5]. Dreiseidler et al.[8] mentioned that diagnostic sensitivity and specificity levels with CBCT imaging are as high as or higher than those obtained using other diagnostic methods.

The aim of this study was to describe the patterns of referral and to reveal the type and prevalence of incidental findings such as anatomical variations, pathologies or calcifications in CBCT scans which were obtained for several diagnostic purposes.

Materıal and Methods

This prevalence study was made by using CBCT scans. CBCT images used in the study were acquired on a 3D Accuitomo 170 (3D Accuitomo; J Morita Mfg. Corp., Kyoto, Japan) which were obtained between 2011-2015. The study sample (n= 691) consisted of CBCT scans of patients who were referred for CBCT evaluation to the Department of Dentomaxillofacial Radiology, Gulhane Military Medical Academy, Ankara, Turkey. 202 of 893 images were excluded because of poor diagnostic quality or low FOV size. Images with low FOV size are obtained only for sectional imaging, so they can not provide sufficient information about out of interest regions of maxillofacial area. 691 CBCT images were included to the study.

No ethical approval was obtained from the local ethical committee because only the retrospective data were used. All patients were informed about the procedure and taken their informed consent prior to clinical examinations and radiologic evaluation according to the principles of the Helsinki Declaration, including all amendments and revisions. Collected data were noted and only accessible to the researchers.

All the CBCT images were evaluated by a dentomaxillofacial radiologist who had 12 years of experience in the basis of calcifications which were detected outside of the regions of primary interest. All of the calcifications were detailed classified and reported.

For CBCT evaluations, proprietary manufacturer software (i-Dixel 2.0/One Data Viewer/One Volume Viewer; J Morita Mfg. Corp.) was used. Images were viewed in a dimly lit room on a 30 inch Dell^{TM} 3008WFP Flat Panel Monitor (Dell Inc., Round Rock, TX, USA) at a screen resolution of 1920x1200 pixels and 32-bit colour depth.

Data were analyzed by descriptive statistics. The occurence frequency of incidentally found calcifications in head and neck area was noted. Median and range were used to describe the age of the patients. Statistical analyses were performed using the SPSS software (version 15.0; SPSS Inc., Chicago, IL, USA) and MS Excel 2003.

Results

A total of 691 CBCT scans were assessed. Of 691 CBCT images, it was detected a great preponderance of males (n= 423 (61.2%)). The patients' mean age was 43.5±17.3 years and within the age range of 5 to 84 years. The most commonly preferred reason for CBCT was dental implant planning with 69.5% (n= 480) of the patients in evaluated group. 11.4% (n= 79) were referred for the evaluation of third molars with anatomic structures and 6.7% (n= 46) were for cystic lesion evaluation. The age-gender distribution and frequency distribution of the sample referred for CBCT scans are shown in Table 1. Most frequently referred patient age groups were the 41-50 age group (20.98%) followed by 21-30 age group (19.39%). The least preferred age groups were 1-10 (0.43%) and over 70 group (4.92%). According to this table, the most common reason for CBCT scan was found in 41-50 age group as implant rehabilitation (90.3%, n= 131). It also found that orthodontic reasons were the most common reason for 1-10 and 21-30 age groups respectively (100%, n= 3; 37.3%, n= 22).

Table 1. Age-gender distribution of subjects and distribution of referral reasons of CBCT (n, %)

	Gender		Age Groups								
	Female	Male	1-10	11-20	21-30	31-40	41-50	51-60	61-70	70+	Total
Implant assessment	208 (77.6)	272 (64.3)	N/A	3 (5.1)	38 (28.4)	63 (67.0)	131 (90.3)	120 (97.6)	92 (92.9)	33 (97.1)	480 (69.5)
Cyst	9 (3.4)	37 (8.7)	N/A	5 (8.5)	20 (14.9)	8 (8.5)	7 (4.8)	2 (1.6)	4 (4.0)	N/A	46 (6.7)
Embedded Teeth	6 (2.2)	17 (4.0)	N/A	6 (10.2)	12 (9.0)	4 (4.3)	N/A	N/A	N/A	1 (2.9)	23 (3.3)
Third molar evaluation	27 (10.1)	52 (12.3)	N/A	18 (30.5)	41 (30.6)	13 (13.8)	4 (2.8)	1 (0.8)	2 (2.0)	N/A	79 (11.4)
Trauma	6 (2.2)	9 (2.1)	N/A	4 (6.8)	5 (3.7)	3 (3.2)	2 (1.4)	N/A	1 (1.0)	N/A	15 (2.2)
Orthodontics	9 (3.4)	28 (6.6)	3 (100.0)	22 (37.3)	10 (7.5)	2 (2.1)	N/A	N/A	N/A	N/A	37 (5.4)
Combination	2 (0.7)	5 (1.2)	N/A	1 (1.7)	4 (3.0)	1 (1.1)	1 (0.7)	N/A	N/A	N/A	7 (1.0)
Odontoma	1 (0.4)	3 (0.7)	N/A	N/A	4 83.0)	N/A	N/A	N/A	N/A	N/A	4 (0.6)
Total	268 (100)	423 (100)	3 (100)	59 (100)	134 (100)	94 (100)	145 (100)	123 (100)	99 (100)	34 (100)	691 (100)

N/A : not available

945 incidentally found calcified structures were discovered on 318 (46.02%) of the 691 patients' CBCT scans. 373 (53.98%) scans showed no calcificated findings. Descriptive analysis and frequency of calcifications were shown in Table 2. Among all of the calcifications which were incidentally found in head and neck area, the most common seen calcifications were tonsillolith (86.03%), followed by stylohyoid calcifications (6.24%), antrolith and subdermal calcifications (2.33%). The most prevalent age groups of calcifications were 41-50 age group and followed by 51-60 age group. The distribution of age groups and calcifications is shown in Table 3.

Table 2. Descriptive analysis and frequency of the calcifications

Calcifications	Number of Findings (%)	Number of patients (%)	
		Female	Male
Tonsillolith	813 (86.03)	75 (23.58)	141 (44.34)
Antrolith	22 (2.33)	12 (3.78)	9 (2.83)
Sialolith	9 (0.95)	3 (0.94)	4 (1.26)
Artery calcification	16 (1.7)	4 (1.26)	9 (2.83)
Stylohyoid calcification	59 (6.24)	14 (4.4)	21 (6.6)
Subdermal calcifications	22 (2.33)	8 (2.52)	14 (4.4)
Intracranial calcifications	4 (0.42)	0 (0)	4 (1.26)
TOTAL	945 (100)	116 (36.48)	202 (63.52)

Table 3. Distribution of calcified lesions and age groups

	Age Groups							
	1-10	11-20	21-30	31-40	41-50	51-60	61-70	70+
Tonsillolith	0 (0.0)	9 (4.2)	32 (14.8)	20 (9.3)	54 (25.0)	43 (19.9)	42 (19.4)	16 (7.4)
Antrolith	0 (0.0)	0 (0.0)	3 (15.0)	3 (15.0)	3 (15.0)	5 (25.0)	4 (20.0)	2 (10.0)
Sialolith	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (40.0)	3 (60.0)	0 (0.0)
Artery calcification	0 (0.0)	0 (0.0)	1 (10.0)	0 (0.0)	1 (10.0)	2 (20.0)	2 (20.0)	4 (40.0)
Styloid calcification	0 (0.0)	0 (0.0)	1 (9.1)	2 (18.2)	4 (36.4)	2 (18.1)	1 (9.1)	1 (9.1)
Subdermal calcifications	0 (0.0)	0 (0.0)	2 (9.1)	2 (9.1)	7 (31.8)	7 (31.8)	3 (13.6)	1 (4.5)
Intracranial calcifications	0 (0.0)	2 (50.0)	1 (25.0)	1 (25.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

A total of 809 palatinal tonsil calcifications were found in 212 patients (Figure 1). In addition it is also found 4 patients had calcifications in adenoidal region. 418 of tonsil calcifications were at the right side, 391 were at the left side. Distribution of total tonsil calcifications over their shape is shown in Table 4. Tonsil calcifications were classified according to its shape such as round, irregular and dot-like. Especially round-like shaped tonsilloliths with under 2 mm diameter were considered as dot-like. According to the table irregular shaped tonsil calcifications were the most frequently found, the second most common form was dot-like shaped. It was also found in one patient had totally 23 tonsil calcifications which 9 of them were irregular. Distribution of number of tonsilloliths on CBCT is shown in Table 5.

A total of 22 antroliths were found in 21 patients (Figure 2). Of these 12 were females and 9 were males. Only one patient with bilateral antrolith was detected. Rest of cases were unilateral. Seven patients had nine sialoliths (Figure 3). Of these 3 were females and 4 were males. In two cases there were two sialoliths and in 5 cases there was one sialolith. 35 of the patients had 59 stylohyoid calcifications (Figure 4). 14 of them were females and 21 of them were males. Of these 24 were bilateral and 11 were unilateral. Subdermal calcifications were noted in 22 patients and only four male patients had intracranial calcifications (Figure 5).

Table 4. Distribution of the shape and quantity of tonsilloliths

	Tonsillolith Shape	0 n (%)	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)	6 n (%)	7 n (%)	8 n (%)	9 n (%)	10 n (%)
RIGHT	Dot-like shaped	608 (88.0)	36 (5.2)	22 (3.2)	13 (1.9)	7 (1.0)	4 (0.6)	N/A	1 (0.1)	N/A	N/A	N/A
	Irregular shaped	592 (85.7)	48 (6.9)	21 (3.0)	17 (2.5)	7 (1.0)	2 (0.3)	N/A	2 (0.3)	N/A	1 (0.1)	1 (0.1)
	Round shaped	664 (96.1)	25 (3.6)	N/A	1 (0.1)	1 (0.1)	N/A	N/A	N/A	N/A	N/A	N/A
LEFT	Dot-like shaped	609 (88.1)	40 (5.8)	17 (2.5)	13 (1.9)	6 (0.9)	3 (0.4)	2 (0.3)	1 (0.1)	N/A	N/A	N/A
	Irregular shaped	586 (84.8)	63 (9.1)	22 (3.2)	10 (1.4)	6 (0.9)	4 (0.6)	N/A	N/A	N/A	N/A	N/A
	Round shaped	660 (95.5)	25 (3.6)	4 (0.6)	2 (0.3)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

N/A : not available

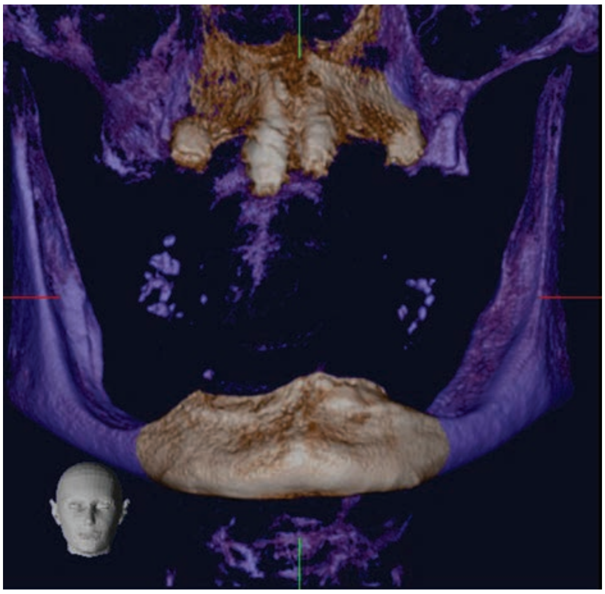

Figure 1. Female patient aged 81. Incidentally found, a very rare case of the calcification of facial artery which is a branch of external carotid artery. Coronal, sagittal axial and 3D reconstructed views

Table 5. Distribution of number of tonsilloliths.

Number of Tonsilloliths	Number of patients (%)
0	479 (69.31)
1	57 (8.24)
2	41 (5.93)
3	27 (3.9)
4	20 (2.89)
5	18 (2.6)
6	11 (1.59)
7	13 (1.88)
8	8 (1.15)
9	8 (1.15)
≥10	9 (1.30)
Total	691(100)

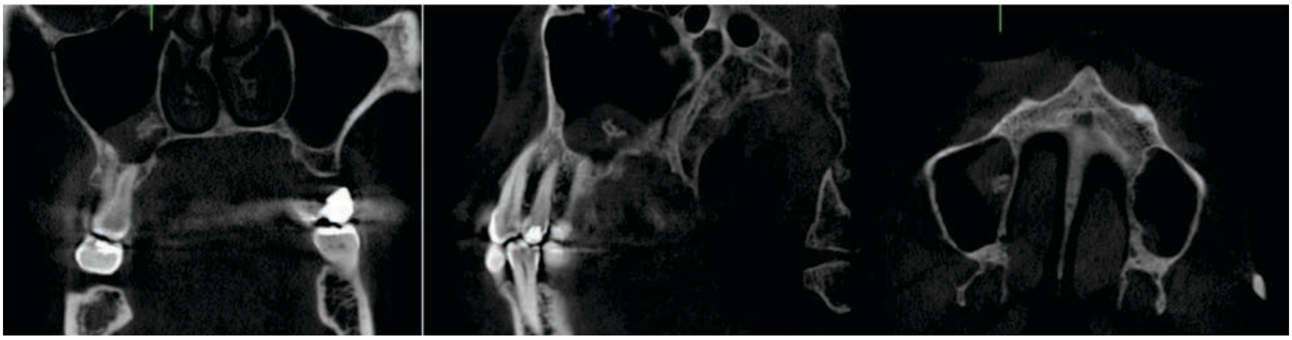

Figure 2. Female patient aged 54. Coronal, sagittal and axial views of an opacification in maxillary sinus

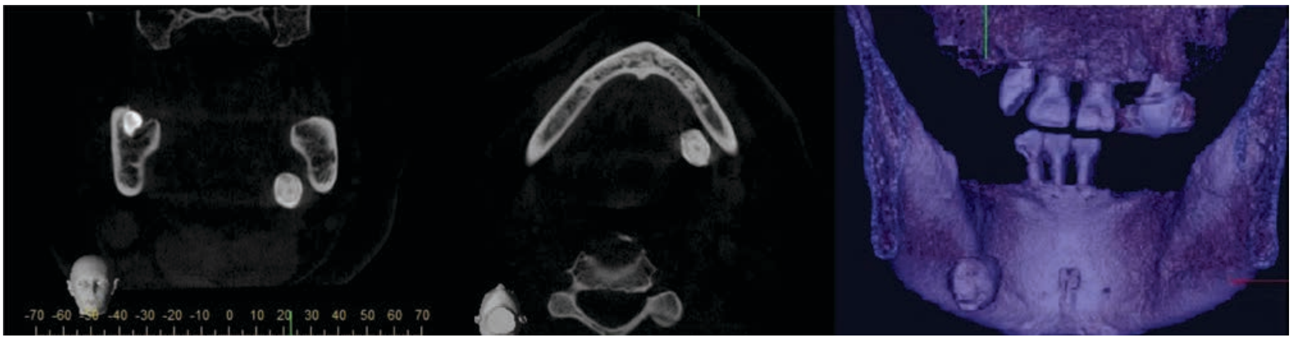

Figure 3. 3D reconstructed view of bilateral multiple tonsilloliths of a female patient aged 83.

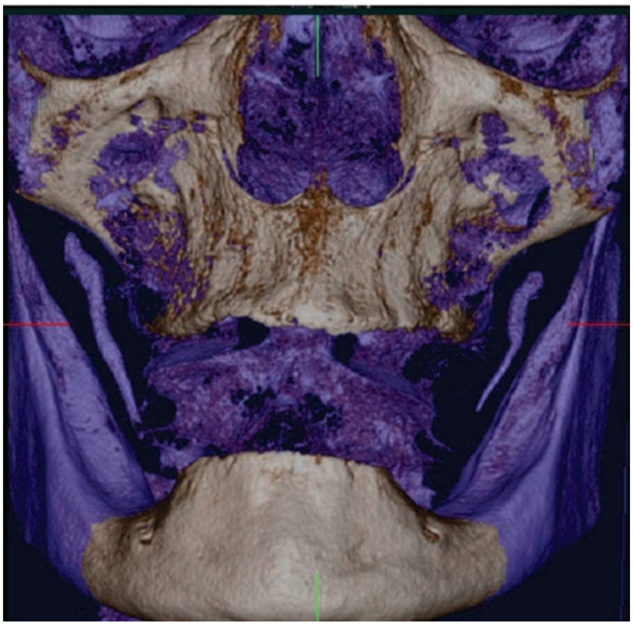

Figure 4. 3D reconstructed view of bilateral elongated stylohyoid process of a female patient aged 69

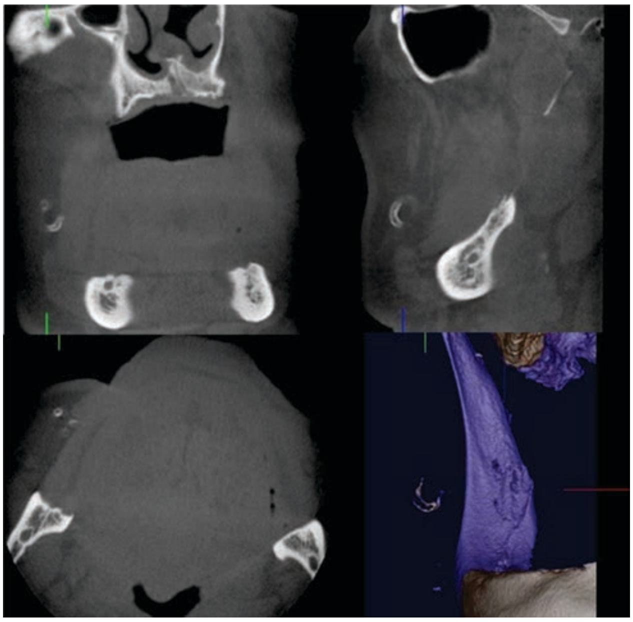

Figure 6. Coronal, axial and 3D reconstructed views of a unilateral sialolith. A well-defined calcified mass was found on the left side of submandibular area of a male patient aged 62

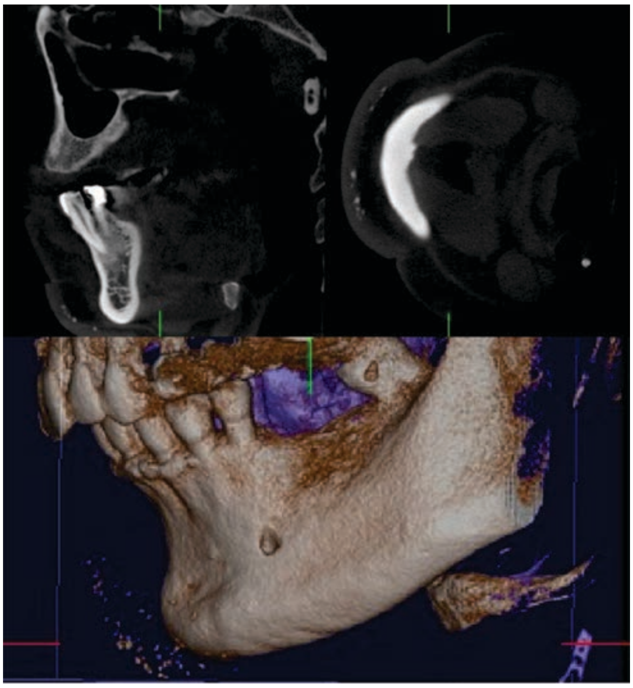

Figure 5. Sagittal, axial and 3D reconstructed views of multiple subdermal calcifications of a female patient aged 45

Thirteen subjects had arterial calcifications (Figure 6). Bilateral arterial calcifications were seen in 3 cases. This situaton was mostly found in over 70 age group (n= 13) and followed by 61-70 age group (n= 5) as expected. A predominance of males was found with a ratio of 9:4 over females.

Discussion

Recently, the use of CBCT for various diagnostic purposes is more common in dentistry. It can provide precious diagnostic information not only from interested area but also the out of the region. The out of interested region findings which is described as incidental findings may sometimes have greater importance of determining an appropriate treatment plan. The purpose of this study was to investigate the characteristics and frequency of calcifications which is incidentally detected.

There are many studies which investigate incidental findings. Some comparable studies are available in literature which were made on specific sample such as orthodontic patients[9-11]. Some authors investigate incidental findings in specific regions such as maxillary sinuses and nasal area[10-14]. In contrast to previous studies, we investigate incidental findings in dento-maxillofacial area of a wider age group of patients.

This study conducted on 691 patients. Comparing the previous studies in literature, to the best of our knowledge, it is the third biggest sample size. The sample size in our study was greater than the studies of Price et al.[2], Cha et al.[3], Rheem et al.[16], Cağlayan and Tozoğlu[4]. But it is less than the studies made by Allareddy et al.[17] and Warhekar et al.[18]. *Larger sample sizes* generally lead to increase the knowledge of clinicians and make possible to provide accurate diagnosis.

The most common reasons for referral were for implant assessment (69.5%) followed by third molar evaluation (11.4%) and cystic lesions (6.7%). In other studies, CBCT referral rate for implant placement varied from 2.72% to 73%[2-4,16-18]. The referral rate of our study was nearly similar with the rates of studies made by Price et al.[2] and Allareddy et al.[17]. Rheem et al.[16] reported that the referral rate of implant patients was 2.72%. The greatest difference of rates is due to the study which previously mentioned was arranged by Orthodontic Division. In addition to referral reasons, it is also found that the most frequently referred patient age groups were 41-50 age group (20.98%) followed by 21-30 age group (19.39%) and 51-60 age group (17.8%). However, Warhekar et al.[18] reported the most frequently referred patients' age group was 21-30 (24%), Rheem et al.[16] reported as 10-19 (44.21%), Price et al.[2] reported as 60-69 (26.33%) and Allareddy et al.[17] reported as 51-60 (22%). The less referred age group was found as 1-10 age group (0.43%). Similarly, Rheem et al.[16] and Price et al.[2] reported that the less referral age group was 1-10 age group.

Of the 691 CBCT scans reviewed, 318 scans (46.02%) showed at least 1 finding. A total of 945 calcifications were found. It is also found 2.97 of rate for per scan. 373 (53.98%) scans showed no calcified lesion. Actually, there are many studies in literature about incidental findings which also contain calcifications. But to the best of our knowledge, this report is the first comprehensive study on the basis of calcifications. It is also seen that the frequency of incidental findings in CBCT shows wide variety in literature. Some studies which conducted with incidental findings present higher frequency rates[2,4,17,19], but some of them have lower frequency than this study[3,16]. It may be due to differences in age groups, target population, sample size or variety of catagorized findings. The authors whose studies previously mentioned did not categorized their findings as a different chapter titled calcifications. Hence, previous reports and our findings should be compared step by step.

Calcifications generally occur in vessels, ligaments, glandular tissues. Sometimes they occur as a result of chronic inflammation or scarring. Soft tissue calcifications in maxillofacial area can be pathological, age-related or idiopathic. Accurate definition of this calcifications is based on some characteristics such as location, morphology and distribution. Due to cross-sectional imaging advantage of CBCT, it become the first choice for accurate diagnosis[2]. In the light of the above information, a total of 945 calcification findings were found in study sample. In a total of 945 calcifications, 813 (86.03%) were tonsil calcifications in 216 patients (31.25%). Distribution of the other calcifications which were found in our study was shown in Table 2. In addition, tonsil calcifications were classified according to their shape. Irregular shaped tonsil calcifications were the most frequently found, the second most common form was dot-like shaped. *To the best* to *our knowledge*, *there is only one report* in literature in which tonsilloliths' shape was classified. Oda et al.[20] found 46.1% of tonsilloliths and reported that the most common shape was dot shaped.

Antrolith is a calcified mass within the paranasal sinuses. Of the 22 discovered antroliths, only one case was bilateral, the others were unilateral. Total number of patients with antrolith were 21 (3.03%). Literature report that the incidences of antroliths are between 0.15%-4.54%[2,14,19,21,22]. Our study presents appropriate result with the above mentioned reports.

One another calcification detected in 7 patients was sialolith. Sialolith is mineral salt deposition in salivary glands or ducts. Seven patients had nine sialoliths. Of these two patients had two calcifications, rest of seven had one sialoliths. According to literature, incidences of sialoliths are low, between 0.3%-0.66%[2,17,18]. In our study we found relatively higher incidence rate (1.01%).

The other calcifications, arter calcification, stylohyoid calcification and subdermal calcifications were, respectively, found in 13 (1.88%), 35 (5.06%) and 22(3.18%) patients. According to literature, incidences of calcifications which mentioned above are between 2.04%-10.04%[2,16,17,23], 6.12%-63.3%[2,16,24] and 2.27%-28%[17,25,26] respectively. In our study the incidences of carotis artery calcification and stylohyoid calcification were relatively lower than those in the above mentioned studies.

Literature reports that intracranial calcifications was common and occur at any age and of any ethnicity. And also Kwak et al.[27] reported that intracranial calcifications are found more commonly in males than in females. In our study, we found only 4 patients who had intracranial calcifications and all of them were males. In addition, frequency of intracranial calcifications of this sample group was found relatively lower than in previous reports (4.76%-71%)[16,17,27-30]. Occurence of differences may be due to many reasons such as sample size, the size of the FOV, radiologic imaging devices and their different abilities in detecting pathologies. Hence, it may be making direct comparisons inappropriate.

Conclusion

In conclusion, clinicians should be aware of incidentally discovered calcified lesions. Correct identification of these findings will reduce unnecessary further diagnostic assessments and will provide more appropriate treatment plans. It will also provide the ability comprehensively evaluation of underlying diseases and practitioners will have life-saving information by early diagnosis.

Note: The results of this paper were awarded for the oral presentation at the 22nd BaSS Congress.

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Correspondence:

Ali Altındağ
Department of Dentomaxillofacial Radiology
Faculty of Dentistry, Ankara Universitty, Ankara, Turkey
e-mail: alialtindag1412@gmail.com