Clinical and Experimental Health Sciences

Evaluation of the Incidental Prevalence of Soft Tissue Calcifications in the Neck Region with Cone Beam Computed Tomography

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ABSTRACT

Objective: The aim of this study was to retrospectively evaluate the incidental prevalence of heterotopic soft tissue calcifications in the neck region, on Cone Beam Computed Tomography (CBCT) images, and their relationship with age and sex.

Methods: A total of 6620 CBCT images were examined. CBCT images of 503 patients aged between 20 and 86 years were included in the study. Patients were grouped into five age groups: 20-30 (N = 132), 31-40 (N = 68), 41-50 (N = 92), 51-60 (N = 104), and 61 and above (N = 107). The images were assessed according to the presence of lymph node calcification, carotid artery calcification, thyroid cartilage, and triticeous cartilage calcification in the neck region. Descriptive statistics, crosstabs, and chi-square tests were used for data analysis. The significance level was set to 0.05

Results: At least one calcification was detected in 372 (73.9%) patients. The difference between the prevalence of each calcification according to age groups was statistically significant. A significant relationship was found between the presence of carotid artery calcification and the sex variable ($p < .05$). The presence of other calcifications did not show statistically significant differences associated with sex ($p > .05$).

Conclusion: The results of this study showed a significant amount of soft tissue calcification in the neck region. The most common calcifications were thyroid cartilage calcifications, and the least common calcification was lymph node calcification.

Keywords: Soft tissue, calcification, neck, cone beam computed tomography

1. INTRODUCTION

Calcium salts are usually stored in the skeleton of the body. These salts are called heterotopic calcification if they are deposited in soft tissue without any organization (1). Calcifications don't show any important symptoms. These are usually detected incidentally during radiographic examination (2). The structures with the most common calcification tendency in the head and neck region are laryngeal cartilages (thyroid, cricoid, and arytenoid cartilages), vertebrae, arteries (carotid artery), and thyroid gland (3). These soft tissue calcifications are generally considered physiological, but sometimes serious diseases may play a role in the etiology of the calcification or calcification may be a manifestation of the disease. Therefore, medical consultation and examination may be required for differential diagnosis. (4). Lymph node calcifications are an indication of specially active or previous tuberculosis, infectious and non-infectious agents such as sarcoidosis, rheumatoid arthritis, fungal infections, sclerosis, neoplastic metastases, cat scratch disease, Bacille Calmette-Guérin vaccine, and chronic inflammation after radiotherapy in lymphomas (2). Carotid artery calcifications are the most important cause of ischemic stroke (5). Calcified thyroid cartilage may affect neurovascular structures, for example, compress the recurrent laryngeal nerve, and bilateral nerve injury may cause difficulty in breathing and loss of ability to speak (aphonia) (6).

Cone Beam Computed Tomography (CBCT) is the preferred three-dimensional imaging method for oral and maxillofacial radiology in recent years (7). Dentists and dentomaxillofacial radiologists usually evaluate only the area of request on the CBCT image. However, various incidental findings such as soft tissue calcifications are ignored by dentists and dentomaxillofacial radiologists because soft tissue resolution of CBCT is not sufficient (4). Whereas even soft tissue calcifications with a volume of 1 mm^3 can be visualized by CBCT (5). Therefore, research on soft tissue calcifications has increased in recent years on CBCT images (4,5,8-14). In the

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literature, studies on this subject have generally evaluated these calcifications alone or a few together. In this study, unlike other studies, all soft tissue calcifications in the neck region were examined.

The aim of this study was to retrospectively evaluate the prevalence of lymph node, thyroid cartilage, triticeous cartilage, and carotid artery calcifications, and their relationship with age and sex.

2. METHODS

2.1. Ethical Considerations

Ethics approval was obtained from the Gazi University Clinical Research Ethics Committee before starting the study (Research No: 2018-192 Ankara, Turkey). This study was conducted in accordance with the principles defined in the Helsinki Declaration, including all revisions.

2.2. Study Design

In this study, 6620 CBCT images in the archive of Gazi University Faculty of Dentistry, Department of Dentomaxillofacial Radiology were examined. The images obtained from the maxillofacial region, with a Field of View (FOV) 16.0 cm × 9.2 cm, or only the mandible region (FOV: 16.0 cm × 5.2 cm) including the neck region were selected. In total, the CBCT images of 503 patients have been included in the study. CBCT images of the patients who had a history of maxillofacial trauma or operation, images with various artifacts (motion artifact, metal artifact, noise artifact, etc.) affecting the image quality, calcifications smaller than 1 mm^3, and undifferentiated calcifications were excluded from the study. CBCT images were obtained by Planmeca ProMax 3D Mid (Planmeca, Helsinki, Finland), the device using parameters of 90 kVp, 10 mA, total scanning time of 13,519 seconds, and 400 µm voxel size. The images were assessed as the presence of lymph node calcification (Fig. 1, Fig. 2), carotid artery calcification (Fig. 3), thyroid cartilage (Fig. 4), and triticeous cartilage calcification (Fig. 5) (1,15). The prevalence of these calcifications was evaluated. In addition, it was examined whether the relevant calcifications were seen on the right or left, unilateral or bilateral, and the relationship between these calcifications and age, and sex were evaluated. All radiographic evaluations were performed by a specialist dentomaxillofacial radiologist (N.G.I) with five years of experience in Gazi University Faculty of Dentistry, Department of Dentomaxillofacial Radiology. Images were examined in sagittal, coronal, and axial sections. All evaluations were performed on a 24-inch Philips medical monitor with NVIDIA Quadro FX 380 graphics card and 1920×1080 pixel resolution by using the Romexis 4.6.2.R. program (Planmeca Oy, Helsinki, Finland) and in a quiet room with subdued ambient lighting, approximately 50 cm away from the screen.

2.3. Statistical Analysis

The data were categorized and statistically analyzed by using SPSS program version 21.0 (SPSS Inc., Chicago, USA) with descriptive statistics, crosstabs, and chi-square tests. The significance level was set to 0.05.

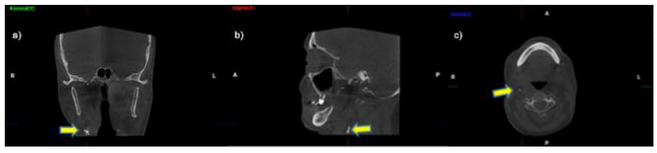

Figure 1. *Cervical lymph node calcification in coronal (a), sagittal (b), and axial sections (c) of CBCT images*

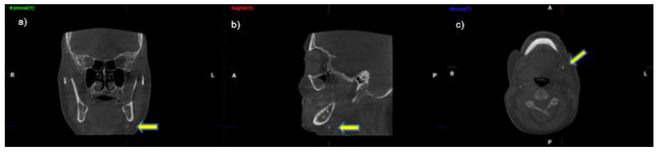

Figure 2*. Submandibular lymph node calcification in coronal (a), sagittal (b), and axial sections (c) of CBCT images*

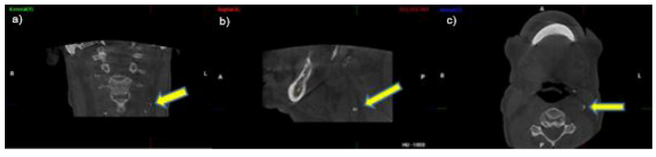

Figure 3. *Carotid artery calcification in coronal (a), sagittal (b), and axial sections (c) of CBCT images*

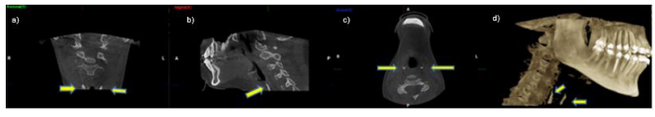

Figure 4*. Thyroid cartilage calcification in coronal (a), sagittal (b), axial sections (c), and 3D reconstruction (d) of CBCT images*

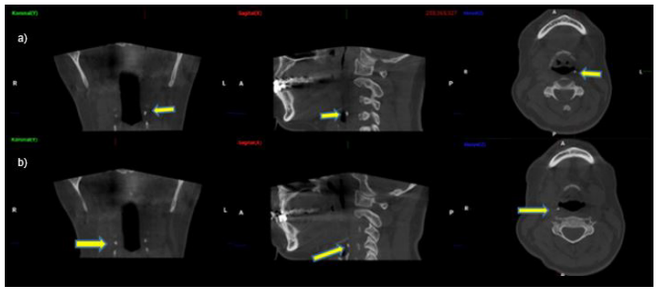

Figure 5*. Triticeous cartilage calcification in coronal, sagittal, and axial sections a) left, b) right of CBCT images*

3. RESULTS

CBCT images of a total of 503 patients aged between 20 and 86 years (mean age ± standard deviation: 45.51±16.05),

consisting of 287 females (57.1%) and 216 males (42.9%) were examined in the study. At least one calcification (lymph node, carotid artery, thyroid, and/or triticeous cartilage) was detected in 372 (73.9%) patients with a mean age of 48.39±14.87.

Patients were grouped as five age groups: 20-30 years (N = 132), 31-40 years (N = 68), 41-50 years (N = 92), 51-60 years (N = 104), and 61 and above years (N = 107) for data analysis. The difference between the prevalence of each calcification according to age groups was statistically significant. The prevalence of lymph node calcification and carotid artery calcification increased in old age. For example, lymph node calcification was more common in patients older than 61 years (17.8%, N = 19) than in patients younger than 40 years (1.5%, N = 1). Thyroid cartilage calcification was less common in patients between the ages of 20-30 years compared to other age groups, for instance, thyroid cartilage calcification was less common in patients aged 20-30 years (39.4%, N = 52) than in patients over 40 years (69.6%, N = 64). Detailed information about the distribution of calcifications according to age groups is given in Table 1. The proportion of patients with lymph node calcification was 6.8% (N = 34), 15.1% (N = 76) with carotid artery calcification, 62.6% (N = 315) with thyroid cartilage calcification, and 21.3% (N = 107) with triticeous cartilage calcification. A statistically significant relationship was found between the presence of carotid artery calcification and the sex (p< .05), and this calcification was more common in males (21.3%, N=46) than in females (10.5%, N=30). There was no statistically significant relationship between the presence of other calcifications (lymph node calcification, thyroid cartilage calcification, and triticeous cartilage calcification) and sex (p> .05) (Table 2). Regarding the affected side (left or right); the most common calcifications were found in right thyroid cartilages (77.7%, N=289) followed by left thyroid cartilages (76.3%, N=284). Left (1.9%, N=7) and right (1.6%, N=6) submandibular lymph nodes had the less common calcifications (Table 3).

Regarding the symmetry (unilateral or bilateral) of the calcifications, 194 (36.3%) were unilateral, and 341 (63.7%) were bilateral. For the calcifications of the thyroid cartilage, submandibular, and cervical lymph nodes, statistically significant differences (p< .05) were found between each of their symmetry prevalence (Table 4). When the prevalence and relationship of each calcification with other calcifications were compared, lymph node calcification-carotid artery calcification, thyroid cartilage calcification-carotid artery calcification, triticeous cartilage calcification-carotid artery calcification, and triticeous calcification – thyroid cartilage calcification were found to be statistically significant (p< .05) (Table 5).

Table 1. *The crosstabs and relationships between age groups and calcifications*

Type of the calcification	Presence of the calcification		20-30	31-40	41-50	51-60	61 ≤	Total	Chi-square	P value
Lymph node calcification	Presence	N	4	1	3	7	19	34	28.251	0.00*
		%	3.0	1.5	3.3	6.7	17.8	6.8		
	Absence	N	128	67	89	97	88	469		
		%	97.0	98.5	96.7	93.3	82.2	93.2		
Carotid artery calcification	Presence	N	7	3	13	13	40	76	57.972	0.00*
		%	5.3	4.4	14.1	12.5	37.4	15.1		
	Absence	N	125	65	79	91	67	427		
		%	94.7	95.6	85.9	87.5	62.6	84.9		
Thyroid cartilage calcification	Presence	N	52	49	64	78	72	315	42.713	0.00*
		%	39.4	72.1	69.6	75.0	67.3	62.6		
	Absence	N	80	19	28	26	35	188		
		%	60.6	27.9	30.4	25.0	32.7	37.4		
Triticeous cartilage calcification	Presence	N	9	23	24	24	27	107	25.342	0.00*
		%	6.8	33.8	26.1	23.1	25.2	21.3		
	Absence	N	123	45	68	80	80	396		
		%	93.2	66.2	73.9	76.9	74.8	78.7		

**p< 0.05 statistically significant*

Table 2. *The crosstabs and relationships between gender and calcifications*

Type of the calcification	Presence of the calcification		Female	Male	Total	Chi-square	P Value
Lymph node calcification	Presence	N	16	18	34	1.488	0.223
		%	5.6	8.3	6.8		
	Absence	N	271	198	469		
		%	94.4	91.7	93.2		
Carotid artery calcification	Presence	N	30	46	76	11.298	0.001*
		%	10.5	21.3	15.1		
	Absence	N	257	170	427		
		%	89.5	78.7	84.9		
Thyroid cartilage calcification	Presence	N	184	131	315	0.632	0.427
		%	64.1	60.6	62.6		
	Absence	N	103	85	188		
		%	35.9	39.4	37.4		
Triticeous cartilage calcification	Presence	N	61	46	107	0.000	0.991
		%	21.3	21.3	21.3		
	Absence	N	226	170	396		
		%	78.7	78.7	78.7		

**p< 0.05 statistically significant*

Table 3. *Frequency of calcification according to localization*

Variables	Absence		Presence	
	n	%	n	%
Submandibular lymph node right	366	98.4	6	1.6
Submandibular lymph node left	365	98.1	7	1.9
Servikal lymph node right	358	96.2	14	3.8
Servikal lymph node left	360	96.8	12	3.2
Carotid artery right	315	84.7	57	15.3
Carotid artery left	319	85.8	53	14.2
Thyroid cartilage right	83	22.3	289	77.7
Thyroid cartilage left	88	23.7	284	76.3
Triticeous cartilage right	296	79.6	76	20.4
Triticeous cartilage left	294	79.0	78	21.0

Table 4. *Comparisons between unilateral prevalence and bilateral prevalence of calcifications*

Variables	Unilateral		Bilateral			
	n	%	n	%	χ^2	P
Submandibular lymph node calcification	11	91.7	1	8.3	8.33**	0.004
Cervical lymph node calcification	24	96.0	1	4.0	21.16**	0.000
Carotid artery calcification	42	55.3	34	44.7	0.84	0.359
Thyroid cartilage calcification	57	18.1	258	81.9	128.26**	0.000
Triticeous cartilage calcification	60	56.1	47	43.9	1.58	0.209

** *p< 0.01*

Table 5. *The crosstabs and relationships between each calcification and the others*

			Carotid artery calcification				
			Absence	Presence	Total	χ^2	p
Lymph node calcification	Absence	n	408	61	469	23.92**	0.000
		%	81.1	12.1	93.2		
	Presence	n	19	15	34		
		%	3.8	3.0	6.8		
	Total	n	427	76	503		
		%	84.9	15.1	100.0		
Thyroid cartilage calcification	Absence	n	149	39	188	7.43**	0.006
		%	29.6	7.8	37.4		
	Presence	n	278	37	315		
		%	55.3	7.4	62.6		
	Total	n	427	76	503		
		%	84.9	15.1	100.0		
Triticeous cartilage calcification	Absence	n	328	68	396	6.17*	0.013
		%	65.2	13.5	78.7		
	Presence	n	99	8	107		
		%	19.7	1.6	21.3		
	Total	n	427	76	503		
		%	84.9	15.1	100.0		
			Lymph node calcification				
Thyroid cartilage calcification	Absence	n	174	14	188	0.23	0.635
		%	34.6	2.8	37.4		
	Presence	n	295	20	315		
		%	58.6	4.0	62.6		
	Total	n	469	34	503		
		%	93.2	6.8	100.0		
Triticeous cartilage calcification	Absence	n	368	28	396	0.29	0.593
		%	73.2	5.6	78.7		
	Presence	n	101	6	107		
		%	20.1	1.2	21.3		
	Total	n	469	34	503		
		%	93.2	6.8	100.0		
			Thyroid cartilage calcification				
Triticeous cartilage calcification	Absence	n	175	221	396	36.95**	0.000
		%	34.8	43.9	78.7		
	Presence	n	13	94	107		
		%	2.6	18.7	21.3		
	Total	n	188	315	503		
		%	37.4	62.6	100.0		

** p<0.05; ** p<0.01*

4. DISCUSSION

Soft tissue calcifications are usually detected incidentally during radiographic examination by dentists and dentomaxillofacial radiologists (2). These soft tissue calcifications are generally considered physiological and may have little clinical significance (4). Although these soft tissue calcifications are generally considered physiological and have little clinical significance, some cases may be life-threatening (8,16). The radiographic appearance of this condition may help to make the correct diagnosis of the patient. Previous studies have reported that the prevalence of soft tissue calcifications for the head and neck region ranges from 12.92% to 62.6%. (4,8,10-14). Due to the relatively high prevalence of the condition, the prevalence of soft tissue calcification in the head and neck region on CBCT images should be determined, thereby raising the awareness of dentists about early diagnosis. (17). In addition, the CBCT-receiving dentist or dentomaxillofacial radiologist is responsible for identifying every finding in the field of imaging because accurate documentation is indispensable in a medical profession. The American Academy of Oral and Maxillofacial Radiology (AAOMR) and the European Academy of Dentomaxillofacial Radiology (EADMFR) have identified the need for the careful examination of all CBCT images within the FOV (4).

The results of this study showed that 73.9% of patients had at least one soft tissue calcification in the neck region. This result indicates that calcifications are quite common. To the best of our knowledge, there are a limited number of studies in the literature about soft tissue calcifications including the neck region evaluated with CBCT (4,8,10-14). However, these studies evaluate both head and neck regions and show prevalence differences ranging from 12.92% to 62.6% in general. This may be due to different age groups, populations, assessment methods (such as evaluation of different incidental findings, including soft tissue calcifications), evaluation of different soft tissue calcifications in the evaluated anatomical regions, and differences in sample size.

Lymph node calcifications in the neck are rare (18). The prevalence of lymph node calcification was found to be 6.8% in the present study. The mean age of the patients with lymph node calcification was 57 years, and the most common age was 61 years. There are few studies on the prevalence of lymph node calcification (8,18-20). Missias et al. (8) reported only one lymph node calcification on 626 CBCT images. Eisenkraft and Som found a 1% prevalence of calcified lymph nodes on 2300 Computed Tomography (CT) images (19). It has been reported that the prevalence of lymph node calcification in the neck region was 1-7% in tuberculosis patients (20). Barghan et al. (18) found that the prevalence of lymph node calcification in CBCT was 0.77%, and the mean age of their study group was 64 years.

Three-dimensional CBCT technology allows us to see the exact location of these calcifications that may be indicative of subclinical atherosclerosis (11). In the literature, several imaging methods were used for the detection of carotid artery calcifications. In most of the studies, panoramic radiographs were used to determine the prevalence of carotid artery calcification, and it has been reported as in the range of 0.43%-29% (21-23). The prevalence of carotid artery calcification was found as 22.9% in CT (16). In CBCT studies, the prevalence of carotid artery calcification was found to be 1.5-10.41% (3,7,10,13,17,22,23). In the present study, the prevalence of carotid artery calcification was 15.1%. This result was slightly higher than in previous reports (4,8,11,13,14,18,24,25). The reason for this situation may be due to the difference in the study sample, age range, and section thicknesses used in CBCT in the previous studies. Its unilateral prevalence was 55.3%, and its bilateral was 44.7% in this study. Damaskos et al. (12) indicated that the unilateral prevalence of carotid artery calcification was higher (56.95%) than bilateral ones (43.05%) in the CBCT study. In another study, using CT images, bilateral carotid artery calcification was more common than unilateral (24). The prevalence of unilateral carotid artery calcification was higher than bilateral in previous studies (12,25) compatible with the present study. Previous studies have emphasized that it was most common at the age of 60 years (4,10,12,25). In the present study, carotid artery calcification was seen at most 61 years of age in accordance with previously published articles (4,10,12,25). On the other hand, Özdede et al. (4) found that carotid artery calcification was seen in 11.6% of females and 4.4% of males, with a statistically significant difference. In the present study, the presence of carotid artery calcification was higher in males (21.3%) than females (10.5%) in accordance with Togan et al. (25). Differences between these carotid artery calcification studies and this study may be due to different factors such as the number of populations in the study, the difference in imaging method used (CT or CBCT or panoramic), section thicknesses, and evaluation criteria.

The thyroid cartilage is the largest of laryngeal cartilages. In humans, thyroid cartilage calcification usually occurs after the end of adolescence period (6). There are few studies on the prevalence of thyroid cartilage calcification on CBCT (8,11,18,26). In those studies, the prevalence of thyroid / triticeous cartilage calcifications was found to be 3.9% – 59.3% (8,11,18,26). Nandita Shenoy et al. (6) evaluated the calcification frequency of thyroid and cricoid cartilage on lateral cephalometric radiographs and reported it as 28%. In another lateral cephalometric radiographic study, the prevalence of thyroid cartilage calcification was 26.2%, more common in males (36%) than in females (19%), and was most common in individuals over 40 years of age (27). Calcification for thyroid cartilage starts in the early 20s and then spreads to cartilage with aging. This process is markedly different between individuals over time. In addition, this process has gender differences in the action of hormones (28). In the present study, the prevalence of thyroid cartilage calcification was 62.6%. The relationship between age groups and the presence of thyroid cartilage calcification was statistically significant, and the most common age group was 51-60 years old. It was more common in females (64.1%) than in males (60.6%). These prevalences were relatively higher than in previous studies. This may be due to the imaging method (CBCT or lateral cephalograms) and the number of samples and the difference in the male-female distribution in the samples.

There are few studies in the literature investigating triticeous cartilage calcification in different populations with different methods (8,29,30). Alqahtani et al. (29) and Hatley et al. (30) also reported triticeous cartilage calcification on computed tomography images of the neck. In these studies (29,30), the prevalence of triticeous cartilage calcification was 12% – 65% on CT. Alqahtani et al. (29) also reported that 37% of triticeous cartilage calcifications were unilateral and 63% bilateral. In studies using panoramic radiography images, the prevalence of triticeous cartilage calcification was reported as 8.6%-10.6% (31,32). In this study, the prevalence of triticeous cartilage calcification was 21.3%, the unilateral prevalence of triticeous cartilage calcification was 56.1% and the bilateral prevalence was 43.6%. Contrary to the previous study (29), the reason why the prevalence of unilateral triteceous cartilage was higher than bilateral in this study may be due to the different imaging devices used, the evaluation of different populations, and the evaluation of different age ranges. The prevalence of triticeous cartilage is stated not to be related to age in the literature (8,29). Unlike the ones published in this study, the relationship between age groups and the presence of triticeous cartilage calcification was found to

be statistically significant; triticeous cartilage calcification was found about 5 times more in patients over 30 years of age compared to patients between 20-30 years of age. There was no statistically significant relationship between triticeous cartilage calcification and sex. In the panoramic radiographic study performed by Aoun and Nasseh (32), the prevalence of triticeous cartilage calcification was 58.5% in females and 42.5% in males. In the study of Missias et al. (8), the prevalence was 6.6% in females and 6.8% in males. These previous studies reported no statistically significant relationship between triticeous cartilage calcification and sex, so our study also supported this finding.

This study had some limitations. Our study was a retrospective radiographic study, thus the possible systemic diseases and complaints of the patients were not known. In addition, due to the absence of a soft tissue window in CBCT, calcifications were difficult to localize, and these calcifications were not confirmed.

5. CONCLUSION

In the study, the prevalence of soft tissue calcifications in the neck region on CBCT images was investigated. The most common calcifications were thyroid cartilage calcifications, and the least common calcifications were lymph node calcifications. The results of this study showed a significant amount of soft tissue calcification in the neck region. Dentomaxillofacial radiologists or dentists should examine the CBCT image as a whole, and keep in mind that there may be soft tissue calcifications in the neck region, and patients should be medically consulted or followed up when necessary.

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Acquisition of data for the study: NGİ
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