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Prevalence of soft tissue calcifications in CBCT images from the Oral and Maxillofacial Radiology Service at UNAB, Viña del Mar, Chile.

Prevalencia de calcificaciones en tejidos blandos en CBCT del Servicio de Radiología Oral y Maxilofacial de la UNAB sede Viña del Mar, Chile.

Patricio Meléndez-Rojas.[1]
Leniz Arancibia-Mesas.[1]
Carolina Poblete-Carrasco.[1]

Affiliations:
[1]Facultad de Odontología, Universidad Andrés Bello, Viña del Mar, Chile.

Corresponding author: Patricio Meléndez-Rojas. Facultad de Odontología, Universidad Andrés Bello, Quillota 980, Viña el Mar, Valparaíso Chile. Phone: (56-9) 85963818. E-mail: patriciomelendezrojas@gmail.com

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Abstract: Soft tissue calcifications can indicate the presence of more serious, potentially life-threatening pathologies. Therefore, their study can lead to an early diagnosis of those conditions that have not yet become clinically apparent. **Main objective:** To determine the prevalence of calcifications in soft tissues of the head and neck in cone beam computed tomography images obtained from the Oral and Maxillofacial Radiology Service at Universidad Andrés Bello (UNAB), Viña del Mar, Chile. **Material and Methods:** Retrospective, cross-sectional, quantitative study. A total of 288 images of cone beam computed tomography (CBCT) were used. Images were obtained at random from the database of the Oral and Maxillofacial Radiology Service at UNAB, Viña Del Mar, between 2014 and 2019. **Results:** A prevalence of 59.72% of soft tissue calcifications was obtained. The most prevalent were: tonsilloliths and calcified stylohyoid ligament, accounting for 30.65% and 45.56%, respectively. **Conclusion:** A high prevalence of soft tissue calcifications was found in a population that has not been studied previously; therefore, it is important that the dentist perform a detailed analysis of the cone beam computed tomography.

Keywords: *Prevalence; cone-beam computed tomography; calcinosis; ligaments; palatine tonsil; dentistry.*

Resumen: **Introducción:** Las calcificaciones en tejidos blandos pueden indicar patologías más graves, que incluso pueden comprometer la vida. Por lo tanto, investigarlas puede conducir a un diagnóstico temprano de aquellas que aún no se han manifestado clínicamente. Objetivo principal: determinar la prevalencia de calcificaciones en tejidos blandos de cabeza y cuello en tomografía computarizada de haz cónico del Servicio de Radiología Oral y Maxilofacial de la UNAB, Viña del Mar, Chile. **Material y Métodos:** Estudio retrospectivo, transversal, cuantitativo. Se utilizaron 288 volúmenes de tomografía computarizada de haz cónico (CBCT, por las iniciales en inglés de Cone Beam Computed Tomography), obtenidas al azar, de la base de datos del Servicio de Radiología Oral y Maxilofacial de la Universidad Andrés Bello

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(UNAB), Viña del Mar entre 2014 y 2019. **Resultados:** Se obtuvo una prevalencia de 59.72% de calcificaciones en tejidos blandos. Las más prevalentes fueron: tonsilolitos, con un 30,65% y ligamento estilohioídeo calcificado, con un 45,56%. **Conclusión:** Se encontró una alta prevalencia de calcificaciones en tejidos blandos en una población que no ha sido estudiada previamente, por ello es importante que el odontólogo realice un análisis detallado de la tomografía computarizada de haz cónico.

Palabra Clave: *Prevalencia; tomografía computarizada de haz cónico; calcinosis; ligamentos; tonsila palatina; odontología.*

INTRODUCTION.

Soft tissue calcifications in the head and neck region result from mineral deposits and can have pathological, age-related, or idiopathic causes.[1] Unorganized deposition of calcium salts can occur in any soft tissue. This condition is known as heterotrophic calcifications,[2] of which there are three types: dystrophic calcification, metastatic calcification, and calcinosis.[3]

It is important to consider that, in addition to understanding the nature of these calcifications, knowledge of their prevalence is necessary to interpret any dental radiographic examination.[1] In turn, knowing the visual characteristics of the calcification helps to develop a differential diagnosis and facilitates proper management. That is why Cone-Beam Computed Tomography (CBCT) images are particularly useful.[1,4]

The soft tissue calcifications observed in CBCT images and which were considered in this study are: tonsillolith (T), calcified stylohyoid ligament (CSL), sialolith (S), cutaneous calcinosis (CC), phlebolith (Ph), antrolith (A), calcified lymph node (CLN), calcified triticeous cartilage (CTC), calcified carotid artery atheroma (CCAA), calcification of the superior cornu of the thyroid cartilage (CSCTC).[1]

Although most of these calcifications are asymptomatic and diagnosed incidentally, some require intervention or monitoring due to clinical repercussions and their relationship to systemic or even life-threatening diseases.[1,2] Examples of such conditions are: sialoliths that may be related to pain, inflammation, and dysfunction of the salivary glands;[5] calcification of the styloid process, which can project to the tonsillar fossa and irritate nearby anatomical structures, causing recurrent odynophagia, foreign body sensation, and facial pain;[6] additionally, it may also be related to Eagle syndrome[7] (with an incidence of symptoms of 4.0% to 10.3%);[8] calcification of the carotid artery, which is associated with an increased risk of stroke and cardiovascular disease;[9] calcification of lymph nodes, which can occur in patients with chronic inflammatory diseases, tuberculosis and even neoplasia;[10] tonsilloliths, the largest of which can cause halitosis, odynophagia, dysphagia or sensation of a foreign body, and require medical treatment;[11,12] and cutaneous calcinosis, which clinically can range from localized and asymptomatic nodules to those that involve large areas of the body, causing muscle atrophy, joint contracture, and skin ulceration.[13,14]

Prevalence data about soft tissue calcifications observed in CBCT images are varied. Studies have found that 35% present some form of soft tissue calcification.[15,16] Other studies report a prevalence of 20%,[17] 20.53%,[10] 12.92%,[18] and up to 62.6%[1] of soft tissue calcifications using CBCT images in different populations. Furthermore, it has been documented that the older the patient, the greater the number of calcifications,[19,20] and that these tend to be more frequent in males.[2,21] Additionally, it has been observed that the bimaxillary field of view (FOV) presents the highest prevalence.[1]

As previously mentioned, it is important for the clinician to have a solid knowledge of the radiographic presentation of calcifications in various structures, particularly in CBCT images,[4] which provide information in the three planes of space on the position of the structures, overcoming the inherent disadvantage of two-dimensional imaging of dental radiographs. In addition, it covers the complete volume of the head and the entire maxillofacial area. As such, it is possible to detect abnormalities outside of the specific region of interest. This is essential, particularly when findings occur in areas related to vital anatomical structures.[21]

Also, as its name implies, the beam is cone-shaped, allowing the capture of a larger FOV.[22] The latter

can be modified and determined to study the region of interest, thereby increasing the ability to identify incidental findings.[19]

The small number of studies conducted on this issue have shown various limitations regarding the reliability of the data about prevalence in relation to findings using CBTC images.[22] Moreover, very few have studied the prevalence of calcifications in soft tissue using CBCT images with different sizes of FOV.[1] Therefore, it would be a contribution to carry out more studies aimed at recognizing the types and frequency of incidental findings in each type of FOV to avoid the underestimation or overestimation of substantial anomalies.[19] It should also be noted that there are no published studies carried out in the Chilean population.

This research aims to study the prevalence of soft tissue calcifications using different sizes of FOV, which may have implications for the health of patients. There are also some soft tissue calcifications that, although they do not need treatment, are highly prevalent and can get differential diagnoses of calcifications that do need treatment.[4,22] The aim is also to provide useful information to the clinicians when studying a finding in CBCT images and help them decide the most suitable treatment, so that in this way, patients can receive timely care with appropriate therapy and, consequently, stop the progression of a disease.[22]

MATERIALS AND METHODS.

This is a retrospective, cross-sectional and quantitative study; CBCT images obtained from the database of the Oral and Maxillofacial Radiology Service of Universidad Andrés Bello University (UNAB), Viña Del Mar, between the years 2014 to 2019, were included in the study. The examinations were performed using the GENDEX GXCB-500 imaging unit at 120 kV, 5 mA, with an exposure time ranging between 12.6 and 23 seconds, and a voxel size of 0.125 or 0.2 millimeters. Reconstructions of the volumetric data set were created using ICatVisionQ software (Imaging Sciences International, 2004-2008).

The CBTC images had to meet the following inclusion and exclusion criteria. Inclusion criteria: CBCT images available at the database of the Oral and Maxillofacial Radiology Service at UNAB, Viña Del Mar, with the following fields of view: maxillary, mandibular, bimaxillary; CBCTs must have been produced by the "GENDEX GXCB-500" unit. Exclusion criteria included: blurred images or with significant artifacts that made observation difficult, patients with malformations or with the presence of foreign bodies that made visualization difficult in the area under study.

Sample size was calculated for a confidence level of 95%, and a margin of error of 5%, with a population size of 1,147 CBCT images obtained from the database of the Oral and Maxillofacial Radiology Service at UNAB, reaching a sample size of 288 CBCTs used in this research. The study uses probabilistic sampling, since the images were randomly selected using some functions of Microsoft Office Excel.

Prior to the analysis of the images, a calibration process was carried out between examiners: two observers with degrees in dentistry and a specialist in Oral and Maxillofacial Imaging from the Oral and Maxillofacial Radiology Service at UNAB, Viña Del Mar, as a reference. The Kappa test was applied to measure observer agreement, and a value of 0.8 was obtained, corresponding to "very good agreement".

After that, the CBCT analysis was carried out, performing a detailed inspection by anatomical areas. The multiplanar reconstruction of the examination was observed, analyzing the volume in axial, coronal and sagittal slices, with a slice thickness of 0.125 mm or 0.2 mm, taking the specific soft tissue calcifications that are expected to be found as a guide.

In those situations, in which there were more than one CBCT of the same FOV of the same subject, the most current was considered. Likewise, when a subject presented more than one FOV, the bimaxillary or the one with the largest size, regardless of the date of the exam, was considered in the first instance. It should be mentioned that the stylohyoid ligament was considered calcified when it met two criteria independently according to the study by Missias *et al.*,[1]: a length greater than 30 mm, and a clear discontinuity in its visualization on the CBCT. All the findings were registered.

Regarding the variable "Clinical action" included in Table 1, the calcifications considered in this study were ordered as follows:

- Without management: CC, CTC, CSCTC
- Check-up: T, CSL, A
- Referral: Ph, CLN, CCAA, S

The data were collected in a Microsoft Office Excel spreadsheet. Then, through the PSPP program, they were subjected to descriptive statistics for quantitative variables, descriptive statistics for qualitative variables, and the chi-square statistical test to study the relationship

between calcification-gender and calcification-age range.

The variables studied and their response category are presented in Table 1.

RESULTS.

Soft tissue calcifications were found in 172 cases of a sample of 288 CBCTs, with a prevalence of 59.72%. Within these 172 examinations, a total of 248 soft tissue calcifications were found. Some representative images of the calcifications mentioned in the introduction, which were detected during the observations, Figure 1 and Figure 2.

The results obtained in relation to the objectives of this study . Table 2, Table 3, and Table 4.

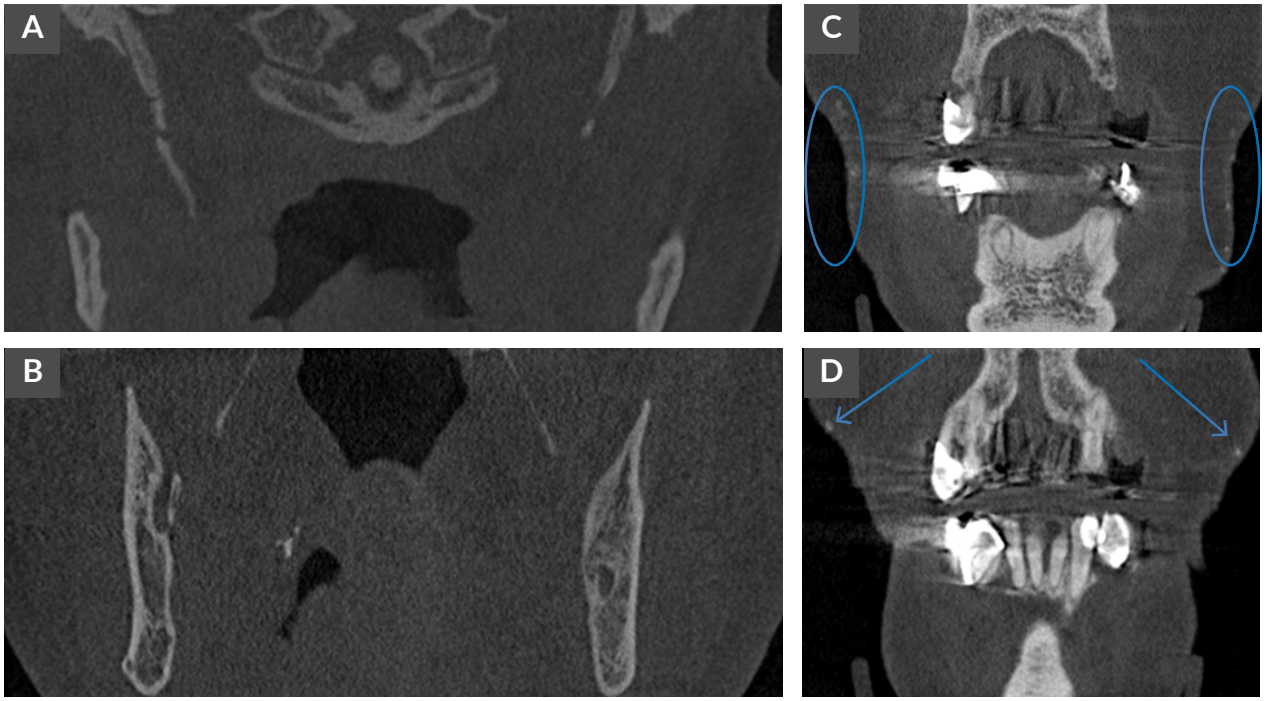
In the course of the research, there arose three types of calcifications not previously considered: insertion of the calcified hyoglossus muscle (ICHM), insertion of the calcified genioglossus muscle (ICGM), and nonspecific calcification (NSC) in the area of the pinna, which were included in the analysis of results (Table 2 and Table 4).

Regarding gender, the most prevalent calcifications registered in females were: CSL (26.39%), tonsillolith (16.32%) and CSCTC (4.52%). While in males they were: CSL (12.84%) and tonsilloliths (10.07%). The other calcifications considered in this study did not exceed 3%. No significant differences were found when applying the Chi-square test ($p>0.05$).

In the analysis by age range, the most prevalent calcifications were tonsilloliths (16-30 years: 4.86%, 31-45 years: 3.12%, 46-60: 8.33%, 61-75: 7,29%), and CSL (16-30 years: 11.81%, 31-45 years: 4.16%, 46-60: 11.81%, 61-75: 7.98%). It was observed that they presented a higher statistically significant prevalence in cutaneous calcinosis ($p=0.002$), in older age (61-75 years: 2.43%) when applying the chi-square test. The remaining calcifications considered in this study did not exceed 2% in prevalence in any age range.

In the specific case of CCAA, of the four registered cases, three were identified in males, and distributed homogeneously from 46 years of age onwards, in the age ranges established in this study.

Figure 1. **Calcifications detected of CSL, T and CC during the observations.**



A. The CBCT in the coronal plane shows bilateral CSL (note the discontinuity in its course). **B.** Sample positive for the expression of the CD44 marker (40x). **C.** Negative sample for the expression of the CD44 marker (40x). **C and D.** Correspond to the same CBCT in the coronal plane with different antero-posterior depth, with CC being observed bilaterally at various points.

Table 1. Variables and response category.

Variables	Response category
Field of view (FOV)	Maxillary, Mandibular, Bimaxillary.
FOV Size	776x776, 680x680, 432x432.
Age range (years)	0-15, 16-30, 31-45, 46-60, 61-75, 75-90.
Gender	Female, Male.
Clinical action	Without management, check-up, referral.

Table 2. Description of the prevalence of each type of calcification detected.

Calcification	Nº	Percentage with respect to the total number of calcifications (%)
CSL	113	45.56
T	76	30.65
CSCTC	17	6.85
CC	13	5.24
A	8	3.23
CTC	5	2.02
NSC	5	2.02
CCAA	4	1.61
S	4	1.61
ICHM	2	0.81
ICGM	1	0.40
Ph	0	0.00
CLN	0	0.00
TOTAL	**248**	**100**

Table 3. Description of the prevalence of each type of calcification detected.

		CBCT with presence of calcification		Demographic data			Clinical action		
				Gender					
FOV	FOV Size	% of the number of CBCTs in each FOV	% of total CBCTs	Female % of total CBCTs with some calcification	Male % of total CBCTs with some calcification	Age range with > prevalence of CBCTs with some calcification	Without manage-ment	Check-up	Referral
Maxillary	776x776	81.97	17.36	9.72	7.64	46 - 60 (n=22)	5.21	15.97	---
	680x680	21.95	6.25	4.51	1.74	61 - 75 (n=8)	22.22	5.90	0.35
Mandibular	776x776	67.74	14.58	11.11	3.47	16 - 30 (n=17)	9.03	12.15	0.35
	680x680	38.89	2.43	2.43	---	46 - 6 (n=3)	3.82	2.43	---
	432x432	---	---	---	---	16 - 30 (n=17)	0.69	---	---
Bimaxillary	776x776	90.00	18.75	11.81	6.94	46 - 60 (n=3)	3.47	17.01	0.35
	680x680	33.33	0.35	---	0.35	16 - 30 (n=17)	0.69	0.35	---
TOTAL		---	**59.72**	**39.58**	**20.14**	**46 - 60 (n=22)**	**45.14**	**53.82**	**1.04**

Table 4. Description of the frequency of calcifications, ordered by FOV.

FOV	Size	Calcification	% of cases with respect to each FOV/size	% of the total of each calcification
Maxillary	776x776 (n=61)	CSL	63.93	34.51
		T	32.79	26.32
		CC	6.56	30.77
		NSC	4.92	60.00
		[S, A, ICHM]	1.64	-- --
	680x680 (n=82)	T	18.29	19.74
		[CSL, S, A]	1.22	-- --
Mandibular	776x776 (n=62)	CSL	43.55	23.89
		T	30.65	25.00
		CSCTC	11.29	41.18
		CC	3.23	15.38
		[A, CTC, CCAA, ICHM]	1.61	-- --
	680x680 (n=18)	T	22.22	5.56
		A	5.26	25.00
		[CSL, S]	11.11	0.89
Bimaxillary	776x776 (n=60)	CSL	75.00	39.82
		T	30.00	23.68
		CSCTC	15.00	52.94
		CC	11.67	53.85
		CTC	6.67	80.00
		CCAA	5.00	75.00
		A	3.33	25.00
		[S, ICGM, NSC]	1.67	-- --
	680x680 (n=3)	[A, CSCTC]	33.33	-- --

[ ]: Those calcifications that presented the same percentages were grouped in order to facilitate reading. These were not specified in the column "% of total", since they cannot be added together. Furthermore, it should be noted that these calcifications correspond to the lowest percentage of cases in each FOV/Size.

DISCUSSION.

The present study found that 59.72% of the analyzed CBCT images presented one or more soft tissue calcifications, similar to that reported by Missias *et al.*,[1] in Brazil in 2018, in which they found a prevalence of 62.6% calcifications in soft tissues.

However, prevalence percentages published in the literature vary significantly. For example, Khan *et al.*,[5] in a study conducted in 2008, reported that 35% had some sort of calcification in soft tissues, which agrees with the study carried out by Well *et al.*,[6] at the University of Louisville in the USA in 2011. Price *et al.*,[7] in a study carried out the same year at the University of North Carolina found 20% prevalence of soft tissue calcifications using CBCT images. In 2013, a study conducted by Rheem *et al.*,[9] at the University of California, USA, reported 12.92% prevalence of calcifications in soft tissues using CBCT. Another study on incidental findings in CBCT images conducted in Brazil by Ivna Albano Lopes10 in 2016 established that soft tissue calcification is the third most frequent finding in the samples, accounting for 20.53%.

The differences detected in terms of prevalence between the studies may be due, on the one hand, to the different populations studied, as they have different demographic characteristics and different sample sizes, the analyses may yield different results. On the other hand, they may also be due to differences in the

methodological approach as well as in the evaluation and analysis criteria used by the different authors when carrying out their studies. In addition, it should be mentioned that the present study used a voxel of 0.125 mm or 0.2 mm, which could partially explain the wide prevalence reported in this study in comparison to other studies which use larger voxels[2,19,22] that may prevent the detection of smaller calcifications.

There are few studies that include FOV. The present research showed a higher percentage of findings in the maxillary FOV, followed by the bimaxillary FOV, and finally the mandibular FOV. This does not coincide with other studies. For example, in the study conducted by Missias *et al.*,[1] the reported prevalence in decreasing order was bimaxillary, mandibular and maxillary FOV; and bimaxillary, maxillary and mandibular, for the study conducted by Lopes *et al.*,[19] This could be due to the fact that in the present study a greater number of CBCTs with maxillary FOV was randomly obtained in the sample, compared to bimaxillary FOV and mandibular FOV.

Likewise, in the first study mentioned, the proportion of examinations analyzed with respect to the FOV is not indicated and, on the other hand, in the second study mentioned, the same number of examinations of each FOV is analyzed. Consequently, these discrepancies may make a difference in the results obtained. It should be also taken into account that the bimaxillary FOV is broader, which may in turn cause an increase in the number of detected calcifications. The mandibular FOV accounted for 17% of the findings, being similar to the 15% reported by Nunes *et al.*,[23] and lower than 25.9% reported by Khojastepour *et al.*[2]

It was observed that the most prevalent calcifications corresponded to calcified stylohyoid ligament and tonsillolith, accounting for 45.56% and 30.65%, respectively. This agrees with the study by Missias *et al.*,[1] in which these calcifications were the most prevalent. On the other hand, it partially agrees with the study by Khan *et al.*,[15] in which the most prevalent soft tissue calcifications were of the carotid artery, triticeal cartilage and tonsilloliths, in an almost equal distribution; and with the study conducted by Togan *et al.*,[22] in which the most prevalent soft tissue calcifications were the stylohyoid ligament and the carotid artery.

Regarding CSL, it was observed that they are mostly grouped in the bimaxillary FOV, which may be due to the fact that in said FOV there is a greater visualization of structures. Tonsilloliths were mostly grouped in the maxillary FOV, which could be due to the fact that the largest number of CBCTs in the sample corresponded to the maxillary FOV.

Regarding clinical management, it was observed that a significantly lower percentage of CBCTs required referral to a specialist, compared to those who required check-up over time or did not need referral or check-up. This agrees with data reported in the literature. It has been generally documented that most calcifications are usually incidental findings, benign in nature and with little clinical relevance.[1,2,4]

On the other hand, it should be noted that the results obtained are not comparable with other studies, as they used different methodologies. While in the present study, in those cases in which more than one calcification was found in the same CBCT, the one with the greatest implication for the patient's health was considered as a determinant for the classification of CBCT in its respective category, in other studies, the results of clinical management for each type of calcification within the same CBCT[1] were presented, and/or a greater variety of calcifications was considered, and not only of soft tissues.[19] There are other studies in which not even clinical management criteria are clearly described.

With respect to gender, the literature seems to be divided regarding the presence of significant differences in soft tissue calcifications. In the present study, a higher prevalence was observed in females, but without significant differences, which agrees with the study by Missias *et al.*,[1] in which no differences were found for any calcification. However, there was a higher prevalence in males except for sialoliths, CC and CSCTC, although for this objective the authors only included examinations with bimaxillary FOV.

Likewise, Lopes *et al.*,[19] did not find any significant differences regarding gender. Togan *et al.*,[22] do not mention significant differences with respect to gender, but they do report that CCAA and antroliths are more frequent in males, and CSL is more frequent in females. On the other hand, Khojastepour *et al.*,[2] found a significant higher prevalence in males, but they only analyzed the mandibular region, and Damaskos *et al.*,[21] found significant differences in extracranial CCAA in males.

It was observed that, as age advances, there appears to be an increase in soft tissue calcifications globally. Despite this, there is no statistically significant relationship that indicates an increase in prevalence. This is in agreement with another study with similar

characteristics;[1] however, it was found that in the literature there are a greater number of studies in which the increase in prevalence is significantly higher in older ages,[2,19,22] including a systematic review from 2013.[20]

Individually, in this study it was observed that cutaneous calcinosis was the only calcification that showed a statistically significant increase in older ages. Regarding this, no similar studies were found in the literature, only case reports, in which ages were highly variable.

Calcified carotid artery atheroma was the most critical calcification for the life of the patient, as the carotid artery provides the main blood supply to the brain.4 In addition, an atheroma is an indicator of risk for stroke or coronary artery disease.[1] So, when these conditions are identified in CBCT images, the patient should be referred to a specialist for cardiovascular evaluation.[1,4,21] In the present study, a prevalence of 1.61% of CCAA was registered, which is lower than what has been previously reported in the literature, where a study suggested a prevalence of 10.7%.[22] However, that study also evaluated other incidental findings, and not only calcifications in soft tissue. On the other hand, another study reports a prevalence of 39.99%,[21] however, that study analyzed a population whose minimum age was 40 years.

The study by Missias *et al.*,[1] which is similar to the present study, found a prevalence of 9.2% in mandibular FOV, and 8% in bimaxillary FOV, which was higher than what was obtained in the present study, where there was 1.61% in mandibular FOV, and 5% in bimaxillary FOV. This could be explained by the differences in the demographic characteristics of both populations.

Regarding the limitations of the present study, it was difficult to make a complete comparison of the results obtained with the results found in the literature. This is mainly due to differences regarding sample size, demographic characteristics of the populations studied, and the methodology used by the authors. Therefore, it is suggested for subsequent studies to work with a larger sample size and to follow a systematization that takes into account similar variables, in order to optimize the comparison of the data available in the literature.

On the other hand, it should be mentioned that, despite having carried out an inter-examiner calibration between two dental residents and a specialist in Dental and Maxillofacial Imaging, experience in observation may be a factor to consider.

It would also be interesting to be able to complement the imaging examination with clinical evaluation, to study the real impact of these imaging findings on the health of the patients, and thus provide appropriate clinical management in each case.

CONCLUSION.

The present study provides useful information on the prevalence of soft tissue calcifications detected in CBCT images in a population from a geographic area for which no records have been found in the literature.

A high prevalence of calcifications detected in CBCT images has been found in the population treated at the Oral and Maxillofacial Radiology Service at UNAB, Viña del Mar, some of which may require check-up, treatment or referral, due to possible clinical repercussions and/or relationship with systemic diseases.

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