Original Article

Prevalence of Soft Tissue Calcifications in CBCT Images of Mandibular Region

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KEY WORDS
Cone beam computed tomography;
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Prevalence;
Mandible;

ABSTRACT

Statement of the Problem: Most of the soft tissue calcifications within the head and neck region might not be accompanied by clinical symptoms but may indicate some pathological conditions.

Purpose: The aim of this research was to determine the prevalence of soft tissue calcifications in cone beam computed tomography (CBCT) images of mandibular region.

Materials and Method: In this cross sectional study the CBCT images of 602 patients including 294 men and 308 women with mean age 41.38±15.18 years were evaluated regarding the presence, anatomical location; type (single or multiple) and size of soft tissue calcification in mandibular region. All CBCT images were acquired by NewTom VGi scanner**.** Odds ratio and chi-square tests were used for data analysis and *p*< 0.05 was considered to be statistically significant.

Results: 156 out of 602 patients had at least one soft tissue calcification in their mandibular region (25.9%. of studied population with mean age 51.7±18.03 years). Men showed significantly higher rate of soft tissue calcification than women (30.3% vs. 21.8%). Soft tissue calcification was predominantly seen at posterior region of the mandible (88%) and most of them were single (60.7%). The prevalence of soft tissue calcification increased with age. Most of the detected soft tissue calcifications were smaller than 3mm (90%).

Conclusion: Soft tissue calcifications in mandibular area were a relatively common finding especially in posterior region and more likely to happen in men and in older age group.

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Introduction

According to Kirsch, [1] physiological mineralization is restricted to specific sites in skeletal tissues, including growth plate cartilage, bones, and teeth. Unorganized deposition of calcium salts however can occur in any soft tissues namely heterotrophic calcifications. [2-3] They are usually associated with chronic inflammation or scarring and more likely to occur in the glandular and vascular tissues, articular cartilage, and ligaments. [4] There are three types of heterotopic calcifications (idiopathic, dystrophic and metastatic). Dystrophic calcification occurs in degenerating, diseased, and dead tissue despite normal serum calcium and phosphate levels. [2]

In contrast, metastatic calcification is the process by which normal undamaged tissues are calcified by means of a hypercalcemic condition like what occurs in hyperparathyroidism. [2]

Radiopaque calcifications are routinely detected in dental radiographic examination and about %4 of

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panoramic views may contain such radiopacities. [5] Inexperienced clinicians may misdiagnose these harmless calcifications and impose unnecessary treatments and costs to patients. Knowledge of prevalence and the nature of these calcifications are necessary to interpret any dental radiographic examination. The most important criteria in diagnostic approach to soft tissue calcifications are anatomical location, distribution, number, size and shape of the calcifications. [1, 5]

Most of the soft tissue calcifications within the head and neck region might not be accompanied by clinical symptoms; however, it should not be assumed that their detection lacks strong clinical significance. [2] The presence of dystrophic calcification in some tissues may suggest the presence of a systemic condition and represent a manifestation of more potentially threatening consequences. [2] It is therefore wisely that dental clinicians improve their understanding of the anatomy of the head and neck structures and potential sites of calcification.

There are several articles regarding the prevalence of various soft tissue calcifications in conventional imaging used in dental practice especially panoramic radiography. [6-11] Conventional imaging; however, provide a two dimensional (2D) representation of a three dimensional (3D) object. In addition many of the structures in the head and neck region are in close proximity to one another and identification of the exact location of an object is one of the greatest difficulties in diagnosing soft tissue calcifications in conventional imaging. This is especially more important and complicated for panoramic radiographs, since it can create ghost images as well. [12] Ghost images may mislead the clinicians into interpreting a unilateral lesion as bilateral one, [3] while CBCT would overcome this difficulty. [16] Misirlioglu *et al.* [12] performed CBCT exam for 7 patients who had bilateral radiopaque lesions at the area of the ascending ramus on panoramic radiographs and showed that these bilateral images were in fact unilateral lesions in 2 cases and the total volume of these calcifications were different considerably, ranging from 7.92 to 302.5mm^3. Moreover the patients with bilaterally multiple and large calcifications were found to be symptomatic. [12] CBCT had a rapid adoption in dental practice, even by practitioners other than those who trained in oral and maxillofacial imaging and is becoming an important part of many dental practices.

Researches on the prevalence, anatomic location and characteristics of soft tissue calcification in CBCT images will aid the clinician to, if not definitively diagnose, at minimum, formulate a differential diagnosis leading to a more appropriate referral protocol. [15] According to the guidelines of the American Academy of Oral and Maxillofacial Radiology, CBCT images constitute a valuable tool for determining the location of soft tissue calcifications. [3, 5]

There are limited CBCT-based studies on the prevalence of soft tissue calcification in head and neck region. [2, 12, 14-15] In 2011, da Silva Nunes *et al.* [15] reported the prevalence of 15% for mandibular soft tissue calcifications among 246 Brazilian patients with no relation to gender and age. [15] Wells and Adam [4] found at least one head and neck soft tissue calcification in 35% of their CBCT samples. Based on their results regarding the incidence of soft tissue calcification, while there was no difference between different genders, it was significantly more found in older age group. [4]

The objective of the present study was to determine the prevalence of soft tissue calcifications in the mandibular region of an Iranian population based on CBCT cross sections and to find their anatomic location, size, and type (single or multiple) as well as their relation to age and gender.

Materials and Method

This cross-sectional retrospective study evaluated the soft tissue calcification in mandibular region of 602 patients including 294 men and 308 women (ranging from 15 to 70) over a 1-year period. The study protocol was approved by the Ethics Committee of Shiraz University of Medical Science (Grant#8876).

The patients were referred to a dentomaxillofacial radiology clinic for taking CBCT as a part of their preoperative recording for other dental procedures including dental implant and/or third molar surgery. Only those CBCT studies in which the mandible was within the field of view (FOV) were included in this study. All CBCT images were acquired in upright standing position by NewTom VGi scanner (QR srl; Verona, Italy, kVp=110, and exposure time of 3.6 s) in

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standard resolution mode (voxel size= 0.3mm) and with FOV= 12×8cm. CBCT cross sections for each patient were reviewed in NNT workstation by authors, for the presence, location, size, and type (single or multiple) of soft tissue calcification in mandibular area. These features were evaluated according to gender and age (under 35 years, from 35 to 45years, from 45 to 55 and over 55 years). The anatomic location of soft tissue calcifications in relation to mandibular bone were categorized into six regions (Figure 1) as follows.

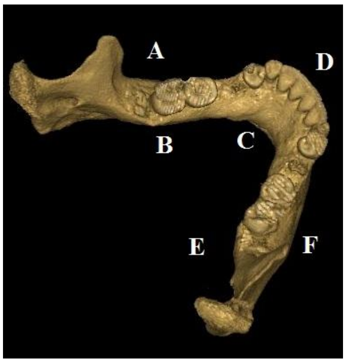

Figure 1: Schematic illustration of the location of the calcifications in the axial plane.

Figure 2: Measuring calcification with CBCT software

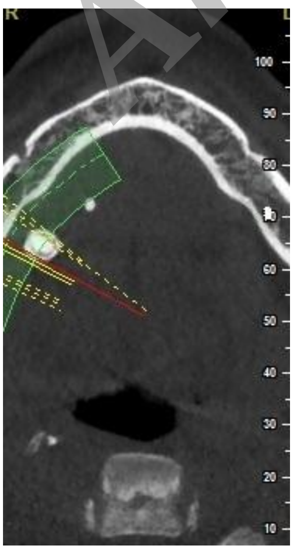

Figure 3: Axial CBCT image of a soft tissue calcification

Regions A and F, which comprised the vestibular aspect of the mandible, extending from the lower first premolars to the edge of the scan (distally); regions B and E, which comprised the lingual aspect of the mandible, extending from the lower first premolars to the edge of the scan (distally); region C, which comprised the lingual aspect of the anterior teeth, from canine to canine; region D, which comprised the vestibular aspect of the anterior teeth, from canine to canine.

Based on the widest diameter in axial cross sections, the size of the soft tissue calcification were measured (Figure 2, 3) and categorized into following groups: equal or less than1mm, between 1 and 3 mm and equal or more than 3 mm (size ≤ 1mm, 1mm <size <3mm, size ≥ 3mm).

Two examiners, one oral radiologist and one postgraduate oral radiology student trained for detection of soft tissue calcification in CBCT images, independently assessed the CBCT images in random order using a monitor (18/5-inch Flatron; LG, Seoul, Korea) in a low-lit room with agreements. Disagreement among examiners was discussed and resolved by consensus. If no consensus was reached, the case was excluded from the study. CBCT data were evaluated in multiplanar sections (axial and coronal and parasagittal cross sections). The brightness and contrast of each and entire acquired images were enhanced to improve visualization of the possible soft tissue calcification. The examiners recorded the presence and characteristic of soft tissue calcification in designated forms.

SPSS software version 17 (SPSS Inc, Chicago, IL) was used to analyze the raw data. Chi-square test and odds ratio were used for statistical analysis and P value < 0.05 was considered statistically significant.

Results

The overall prevalence of soft tissue calcification was 25.9% in studied population and most of them were single in 105 cases (60.7%). 156 out of 602 patients including 89 men and 67 women, had at least one soft tissue calcification. The mean age of patients with soft tissue calcification was 51.7±18.03. The youngest of the patients with calcification was 17 and the oldest was 70 years old.

As shown in (Table 1) men had significantly higher rate of soft tissue calcification than women (30.3%

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Table 1: Distribution of soft tissue calcifications in mandibular region by gender

		Calcification				
Sex	**Frequency**	**No**	**Yes**	**OR***	**%95CI**	**P**
Female	308 (51.2%)	241 (78.2%)	67 (21.8%)	1	_	.017
Male	294 (48.8%)	205 (69.7%)	89 (30.3%)	1.56	(1.08_2.26)	.017

*Odds Ratio

versus 21.8%).

Location, pattern and size distribution of detected soft tissue calcifications in CBCT images of the mandibular region were recorded in Table 2. Buccal anterior region of mandible had the lowest rate of soft tissue calcification in this region; there was only one case of soft tissue calcification in C region. The highest incidence of soft tissue calcification was detected in B, E areas (88%) followed by D and A, F areas respectively. Mandibular soft tissue calcifications were unilateral and less than 3 mm in the most of the cases.

Distribution of the detected soft tissue calcification in CBCT images of the mandibular region of different age group are presented in Table 3. There was a statistically significant difference between the prevalence of soft tissue calcification in different age groups. The prevalence of soft tissue calcification was higher in older age group.44.8% of patients over 55 years old had at least one site of soft tissue calcification compared to about 11% of patients under the age 35 years.

Discussion

The present study provided information about the prevalence, location, size and type (single or multiple) of soft tissue calcification in mandibular region based on CBCT images. To the best of our knowledge, there have been limited researches about the incidence of calcifications on CBCT images. [3-4, 12, 14, 16]

Soft tissue calcification could happen due to physiologic process and as a result of wide range of pathologies. In some cases, presence of calcifications can be suggestive of a specific diagnosis. [2] Caglayan e*t al.* [17] reported a higher incidence of soft tissue calcification in patients with chronic renal failure, compared with normal population. CBCT images, taken for other reasons, can be used to diagnosis bone lesions and soft tissue calcification in some diseases such as chronic renal failure. [17]

Due to the proximity of soft tissue structures to the focal trough, a number of soft tissue calcifications can be detected in panoramic radiographies. [3] Panoramic radiography; however, is inherently planar and like other conventional 2D images, has low diagnostic success in detecting relatively small calcifications. [16] In addition, they have specific limitations such as ghost images.

The diagnostic limitations of conventional 2D images could be improved somehow by using combinations of them. This strategy however, increases the radiation exposure to a level similar to that of low-dose CBCT imaging. [18]

In contrast with panoramic views, CBCT images are not pretentious by magnification, distortion and overlapping of neighboring structures. [19] In addition to detection and precise localization of soft tissue calcifications, CBCT scanning is excellent in determining the size and the shape of them. [15] The resolution of CBCT even in standard mode, which was used in this study, allows detection of calcifications as small as 0.3 -0.4 mm. [15]

Comparing with CT scanning, CBCT has a low dose of radiation to the patient, compact design, shorter examination time and lower cost; therefore, it is more feasible for oral and maxillofacial procedures. [27]

Although the ability of CBCT in detecting small calcified structures in soft tissues has not been evaluated yet, there is consensus on the accuracy of CBCT for various applications in maxillofacial region. [20]

Mischkowski *et al.* [21] compared the diagnostic quality of multiplanar reformations obtained with CBCT

Table 2: Location, pattern and size distribution of detected soft tissue calcification in CBCT images of the mandibular region.

Calcification	Location				Pattern		Size mm		
	A,F	**B,E**	**C**	**D**	**Bilateral**	**Unilateral**	**≤ 1**	**1 <size <3**	**≥ 3**
Frequency	9	198	1	15	58	98	166	160	38
Percent	4.04%	88.79%	0.45%	6.72%	37.2%	62.8%	46%	44%	10%

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Table 3: Distribution of detected soft tissue calcification in CBCT images of the mandibular region in different age group.

		Calcification				
Age	**Frequency**	**No**	**Yes**	**OR***	**%95CI**	**P**
<35	236(39.2%)	210(89%)	26(11%)	1	–	<.001
35–45	116(19.3%)	92(79.3%)	24(20.7%)	2.11	1.11-3.86	
45–55	116(19.3%)	70(60.3%)	46(39.7%)	5.31	3.05-9.21	
≥55	134(22.2%)	74(55.2%)	60(44.8%)	3.85	3.85-11.13	

*Odds Ratio

CBCT and multi detector CT scanner. They concluded that although sharpness, noise level, and contrast resolution do not reach the level of CT, the CBCT images proved to be statistically comparable in detection of these lesions. Suomalainen *et al.* [22] evaluated the accuracy of linear measurements on a human cadaver mandible (two edentulous areas and one dentate area) by using CBCT and MSCT and reported that CBCT generated less error. Pinsky *et al.* [23] used Classic i-Cat® system and concluded that CBCT is an accurate, non-invasive, practical method which could reliably determine the size and the volume of the bony lesions.

In contrast to Nunes *et al.* [15] results which showed a 15 % incidence for soft tissue calcification in CBCT images of mandible of Brazilians population, this rate in the present study was 25.9%. Factors such as the mean age of studied population as well difference in CBCT machines characteristics and resolution could be related to this difference. Nunes *et al.* [15] has not reported the mean age of their study population and only reported the mean age of cases with mandibular soft tissue calcifications (44.98±11.24) which is less than the amount of mean age of the cases with calcification in the present study (51.7±18.03).

The thickness of the image slice (resolution) has also a significant impact on the results. A number of the calcifications may be missed in thicker slices due to partial volume average artifact. [24-25] CBCT images in the present study had higher resolution as they were taken in 0.3 mm thickness slices (standard mode) while the axial slices thickness in both system of Nunes *et al.* [15] study were 0.4mm.

The inability of CBCT in clear differentiate between soft tissue structures could be considered the greatest difficulty in the present study especially when these calcifications are located inside a soft tissue lesion, like a malignant neoplasm, being imperative in differential diagnoses. [13]

The findings of this study cannot be directly compared with those reporting the incidence of various soft tissue calcifications such as tonsilloliths, sialoliths, and osteoma cutis, because only the location of the calcifications in the axial plane has been determined and the calcifications themselves were not classified. Despite all these issues, certain judgments can still be made if the clinician has a broad knowledge of the anatomy of the maxillofacial region. For example, the calcifications that were closer to the midline, adjacent to the oropharynx, in the space that represented the pharyngeal mucosa containing lymphatic tissue are more likely to be tonsilloliths, especially if they are multiple and bilateral. [26-27]

In this study, 68 cases of multiple calcifications were found. The calcifications that were close to the bone surface in the posterior region of the mandible were probably submandibular gland sialoliths within the gland whereas those that were close to the bone surface in the anterior region of the mandible were within Warthon's ducts or sublingual glands. Nevertheless, since the submandibular and sublingual lymph nodes are located within submandibular space, lymph node calcifications should also be considered in the differential diagnosis. The pattern of calcification may help final diagnosis. The calcifications in the external part of the mandible are probably osteoma cutis. [28]

In contrast to the study of Nunes *et al.,* [15] in this study the prevalence of soft tissue calcification in mandibular region were related to both age and gender. According to the present study, the prevalence of soft tissue calcifications increases with age, moreover, men showed significantly higher rate of soft tissue calcification than women. Greater sample and higher size and different CBCT machine characteristics may explain the difference. The sample size in the present study was almost 2.5 times more than the Nunes *et al.*'s study. [15] The difference between various CBCT systems, including differences in type of detectors, the maximum resolution and FOV can lead to different results in vari-

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ous studies. Scarfe *et al.* [16] reported that, although the image detector and scan type of the i-Cat® system generated less noise, better spatial resolution, and better contrast resolution; the radiation dose was higher than the others.

The prevalence of etiologies of soft tissue calcification in specific geographic areas can also be important in obtaining different results. For example, cysticercosis, dystrophic calcifications, is prevalent in countries of Central and South America, Asia and Africa where pork is a popular food. [29]

We did not have access to the clinical information of the cases with calcification and it was not possible to do the supplementary work up to confirm specific diagnosis. The 25.9% prevalence of soft tissue calcifications, found in the present study, emphasizes the importance of careful inspection of serial CBCT images in order to take full advantage of the diagnostic potential of this imaging modality.

In this study, the mandibular landmarks have been selected rather than head and neck landmarks due to the limited FOV selected for imaging.

Considering the superior quality and the current availability and usage of CBCT, it is wisely to re assess the prevalence of important conditions such as soft tissue calcifications based on CBCT images. This will facilitate diagnosis and precise pre-surgical planning in dentomaxillofacial region.

Conclusion

Soft tissue calcifications in mandibular area were a relatively common finding especially in posterior region and more likely to happen in men and in older age group. Considering these findings, proper knowledge and diagnosis of soft tissue calcifications are imperative. Lack of clinical data that could be used for differential diagnosis of calcifications was the limitation of present study.

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Conflict of Interest

None declared.

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