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Prevalence of soft tissue calcifications in the maxillofacial region – a radiographic study

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Aim: To evaluate the prevalence of soft tissue calcifications in orofacial region and their panoramic radiographic characteristics using digital panoramic radiographs among patients reporting to a tertiary dental hospital. **Methods:** 1,578 digital panoramic radiographs were retrieved from the archives and scrutinized for the presence of calcifications. Soft tissue calcifications were recorded according to age, gender, site (left or right). Data were analysed using Chi-square and Fisher's exact test using SPSS software and a $p < 0.05$ was considered statistically significant. **Results:** Among the total number of radiographs, calcified carotid artery (34.3%), calcified stylohyoid ligament (21%), tonsillolith (10.3%), phlebolith (17.6%), antrolith (6.3%), sialolith (5.9%), rhinolith (2.5%) and calcified lymph nodes (1.9%) were identified. The most commonly observed calcifications were calcification of carotid artery and stylohyoid ligament and the least commonly observed calcifications were rhinolith and calcified lymph node. A statistically significant association of the presence of calcifications of carotid artery and stylohyoid ligament on the left and right side was observed in females and tonsillolith on the right side in males (p-value < 0.05). Considering the gender and age group, the occurrence of antrolith among males and rhinolith among females of young-adult population, tonsillolith among the males, calcified carotid artery and stylohyoid ligament among the females of middle-aged population was found to be significant. **Conclusion:** Soft tissue calcifications are often encountered in dental panoramic radiographs. Our study revealed that the soft tissue calcifications in orofacial region were more common in women and were found to be increased above 40 years of age.

Keywords: Radiography, panoramic. Calcinosis. Plaque, atherosclerotic. Eagle syndrome. Diagnostic imaging.

Introduction

Calcium is a micronutrient that is required for a variety of physiological functions such as cellular activities, neuronal activity, tooth and bone formation, etc.[1]. Deposition of calcium salts in the tissues can be manifested in various physiological and pathological conditions[2]. Calcium salts, primarily calcium phosphate gets accumulated in the soft tissues in an unstructured manner resulting in pathological calcifications which is also referred to as heterotopic calcification[3]. Pathologic calcifications can be either dystrophic which occurs in degenerating and necrotic tissues or metastatic which occurs due to the precipitation of excess calcium and phosphate in the normal tissues[4]. Occasionally, such calcifications may occur bilaterally and symmetrically secondary to the skeletal deposits from a malignancy[5,6].

Extra-skeletal calcifications such as calciphylaxis, calcifications within the brain such as primary familial brain calcification, calcifications of tumour, arthritic bone spurs, gall and kidney stones are some of the typical sites of soft tissue calcifications[6,7]. Soft tissue calcifications in the orofacial region are commonly detected as incidental findings during routine radiographic examinations with orthopantomograms (OPGs)[4,8]. Evaluation of such calcification should be carried out in a systematic manner considering the anatomical location, distribution, shape, size and number of calcifications to arrive at an appropriate diagnosis[9]. Digital panoramic imaging is a routinely employed modality for diagnosing pathologies of the jawbones. It is considered as an initial imaging modality that allows appropriate discernibility of the structures of the maxillofacial region[10]. There are various pieces of evidence available in the literature that delineates the detection of soft tissue calcifications in OPG, but the prevalence of such calcinosis differs widely among various studies and the population studied[5].

The calcifications that can be encountered in panoramic radiographs include rhinolith, antrolith, tonsillolith, phlebolith, sialolith, carotid artery calcifications, calcified lymph nodes and stylohyoid ligament[11]. With the increased utilization of digital panoramic imaging in routine dental practices, understanding of the soft tissue calcifications and their characteristics is necessary for formulating a diagnosis and establishing an appropriate referral strategy[12,13]. Hence, considering the wide span of pathologies and the paucity of research, we undertook this retrospective study with the aim of evaluating the prevalence of soft tissue calcifications using digital panoramic radiographs among patients reporting to a tertiary dental hospital.

Materials and methods

Selection of patients

The present retrospective study was carried out after the approval of the Institutional Ethical Committee (ETHICS/ABSMIDS/149/2021). Panoramic radiographs of individuals who had visited the Department of Maxillofacial Radiology from January 2020 to December 2020 were retrieved from the archives and screened based on our inclusion criteria. The panoramic radiographs of all age groups and gender with

good diagnostic quality were included in the study. We obtained a total of 1693 radiographs which were scrutinized for the presence of soft tissue calcifications. However, 115 radiographs were excluded due to the presence of radiographic artifacts, facial deforming pathologies, obscure images with superimposition of structures and lack of diagnostic quality.

Image acquisition

The radiographic images were procured with an orthopantomogram unit, Planmeca ProMax S2-2D (Helsinki, Finland, 2008) using Planmeca Romexis software (Version 2.4.2) and viewed on a full-screen monitor. The panoramic radiographs were taken by a trained radiographer with the exposure parameters of 64-70 kV; 7-14 mA and an average exposure time of 16 seconds. All the images were evaluated by two independent Oral and Maxillofacial Radiologists with a minimum of ten years of clinical experience. The evaluation of the radiographs was done based on parameters such as age, gender, site and type of calcification.

Image analysis

Soft tissue calcifications were classified according to their number, location, shape, distribution (side of involvement) and appearance. For the ease of identification of soft tissue calcifications, the panoramic radiographs were divided into eight equal quadrants by sketching one horizontal and three vertical lines following the method described by Rajkumar et al.[1]. A horizontal line was drawn across the occlusal plane. Vertical lines were drawn across the midline passing through the nasal septum and along the anterior aspect of the mandibular ramus on either side and numbered from 1-8 as shown in figure-1. The soft tissue calcifications were documented based on their anatomical location and the quadrant in which they were present. Table-1 enumerates the calcifications in the maxillofacial region based on their characteristic radiographic appearance as found in our study. The description of the characteristic radiographic features based on the location of the soft tissue calcifications is cited from the previous literature[1,5,9,14-16].

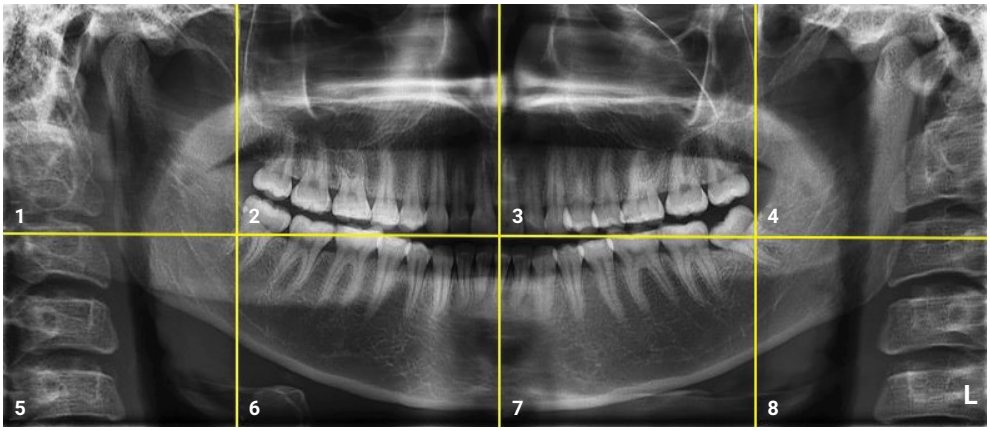

Figure 1. Division of OPG divided into 8 boxes arbitrarily.

Table 1. Characteristics of calcifications located in the maxillofacial region

S.No	Type of Calcification	Number	Radiographic Appearance	Location
1	Antrolith	2nd or 3rd quadrant	• Commonly appears as a solitary radiopacity which is well-defined, round to ovoid, irregular or smooth in outline.	• Seen in the antrum of maxillary sinus.
2	Rhinolith	Medial aspect of 2nd or 3rd quadrant	• These are heterogenous or homogenous radiopacities with a laminar appearance.	• Seen in the nasal fossa.
3	Phlebolith	5th or 8th quadrant	• Seen as small, multiple circular or oval layers of concentric radiolucent and radiopaque rings. • Often, these calcified bodies have the characteristic radiopaque "bulls eye" or "target" appearance.	Common sites are: • Posterior region of body of mandible. • Internal aspect of inferior alveolar canal.
4	Tonsillolith	1st or 4th quadrant	• Appears as unilateral ill-defined radiopacities in clusters.	• Seen superimposed over the mid-portion of ramus along the Oro-pharyngeal air space.
5	Sialolith	1st or 4th quadrant	• Single or multiple, irregularly shaped calcified structures with a smooth outline.	• Submandibular gland sialolith (83-94%) – Along the ramus or angle of the mandible. • Parotid gland sialolith (4-10%) – Along the upper-third of mandibular ramus (within parotid space).
6	Calcified lymph nodes	5th, 8th or lateral aspect of 6th or 7th quadrant	• Calcified structures with "cauliflower-like" lobulated appearance and an irregular periphery.	• Commonly located at the inferior border of mandible near the angle.
7	Atherosclerosis (Carotid artery calcifications)	5th or 8th quadrant	• Irregular, heterogenous vertico-linear radiopacities with a characteristic "pipe-line" or "Tram-track" appearance.	• Seen at the level of intervertebral space between C3 and C4.
8	Calcified stylohyoid ligament	From 1st to 6th quadrant or 4th to 7th quadrant	• Ossified radiopaque ligaments which can be slender, segmented, tapering and often longer than 30 mm.	• Extends from mastoid region to the hyoid bone, crossing the posterior-inferior aspect of mandibular ramus.

Statistical Analysis

Statistical analysis was performed with SPSS statistics program (IBM, Armonk, NY, USA) Version 22 for Windows. Numerical data were represented as mean and standard deviation values. The categorical data were represented as frequencies and percentages and analysed with the help of Fisher's exact test and Chi-squared tests. A p-value of 0.05 was considered to assess the level of significance.

Results

The demographic data of the study subjects are enlisted in Table-2. Our study included a total of 1578 panoramic radiographs which comprised of 644 males and 934 females, and the age of subjects ranged from 7 to 82 years with a mean age of 45.60 ± 15.9 years. Out of 1578 radiographs, only 204 (12.9%) had visible soft tissue calcifications of which 78 (38.2%) were males and 126 (61.8%) were females.

Table 2. Demographic data of the study sample.

Total no. of panoramic radiographs Collected and screened		**1693**
No. of panoramic radiographs excluded		**115**
No. of panoramic radiographs included		**1578**
CHARACTERISTICS OF THE INCLUDED RADIOGRAPHS		
GENDER	n	%
Males	644	40.8
Females	934	59.2
AGE GROUP	n	%
03-39 (Young Adults)	498	31.5
40-59 (Middle aged)	516	32.7
60-99 (Old aged)	564	35.7
CHARACTERISTICS OF THE RADIOGRAPHS WITH CALCIFICATIONS		
No. of panoramic radiographs with soft tissue calcifications		204
GENDER	n	%
Males	78	38.2
Females	126	61.8
AGE GROUP	n	%
03-39 (Young Adults)	83	40.7
40-59 (Middle aged)	90	44.1
60-99 (Old aged)	31	15.1

The study samples were categorized based on the age group classification given by World Health Organization as subjects, between 3 to 39 years as young adults; subjects between 40 to 59 years as middle age and subjects between 60 to 99 years as old age. The majority of soft tissues calcifications observed in our study were more common in the middle-aged (44.1%) population followed by the young adult population (40.7%). Among the 204 calcifications, calcifications of carotid artery (34.3%) were the most predominantly observed calcification followed by calcified stylohyoid ligament (21%), phlebolith (17.6%), tonsillolith (10.2%), antrolith (6.4%) and sialolith (5.9%). The presence of calcification in the nasal cavity (2.4%) and lymph nodes (1.9%) were the least encountered calcifications (Figures-2,3,4 and 5). Subjects identified with soft tissue calcifications comprised of 33% and 35.7% of carotid artery calcifications, 19.8% and 22.4% of calcified stylohyoid complex, 17.9% and 16% of phleboliths, 11.3% and 8.5% of tonsilloliths, 7.5% and 5.1% of antroliths, 6.6% and 5.1% of sialoliths, 2.8% and 2% of rhinoliths, 0.9% and 3% of calcified lymph nodes on left and right sides of the radiographs respectively.

Analysis of Soft tissue calcifications based on various age groups and Gender:

In the present study, the occurrence of antrolith, rhinolith, tonsillolith, calcifications of the carotid artery and stylohyoid ligament ($p > 0.05$) was significant. We found a

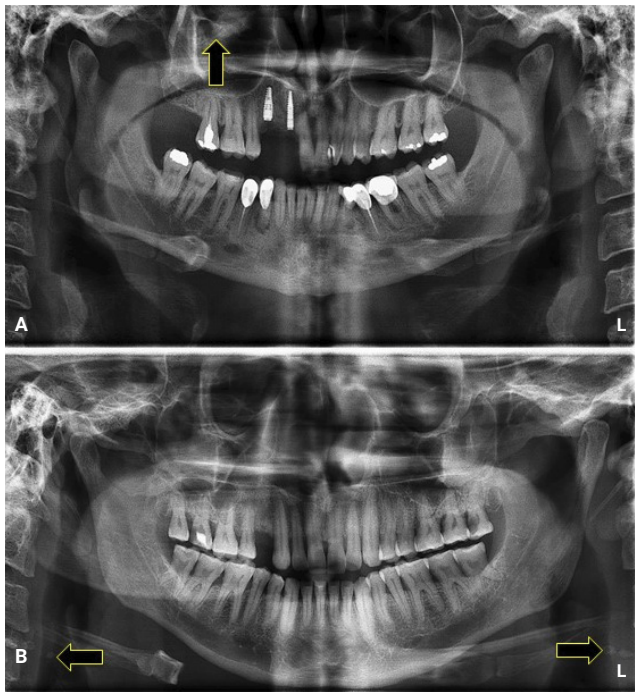

Figure 2. (A) The arrow on the panoramic radiograph showing a radiopaque mass in the right maxillary sinus suggestive of antrolith. (B) The arrows on the panoramic radiograph showing well-defined elongated radiopacity at the level of third cervical vertebrae suggestive of carotid artery calcification.

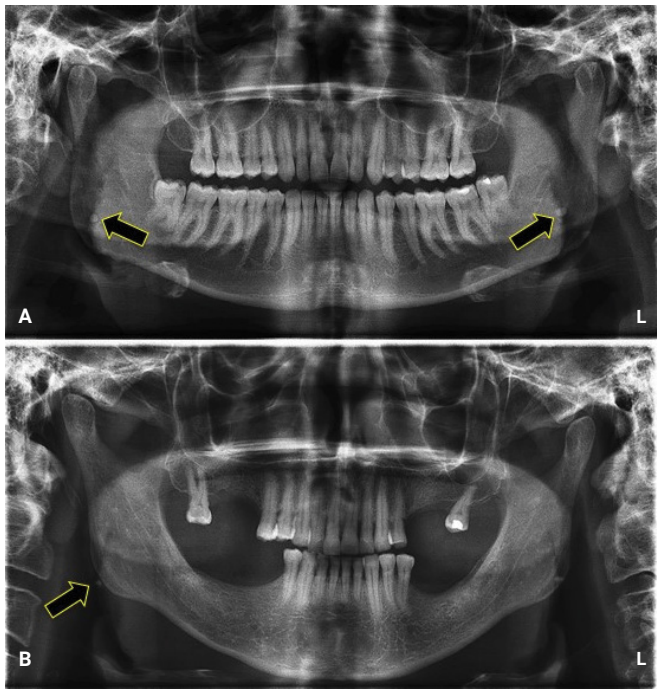

Figure 3. (A) The arrows on the panoramic radiograph showing well-defined circular radiopacities in the internal aspect of inferior alveolar canal bilaterally suggestive of phleboliths. (B) The arrow on the panoramic radiograph showing a radiopacity near the angle of mandible on right side suggestive of sialolith.

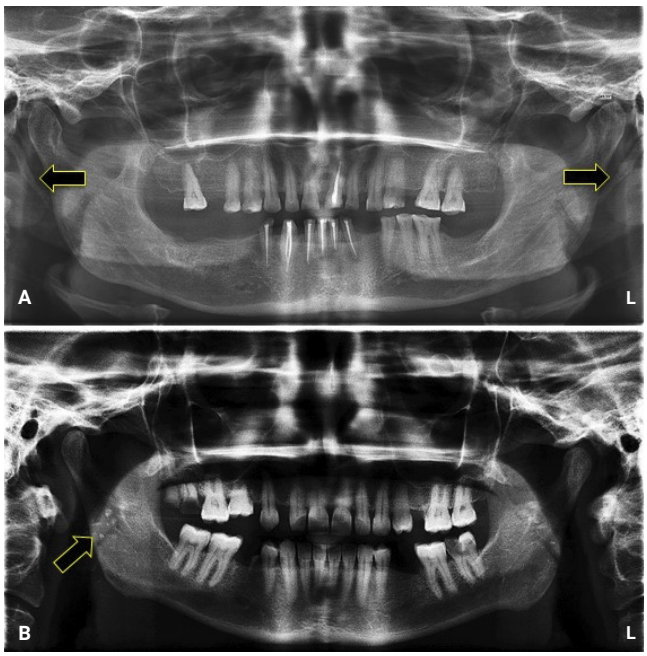

Figure 5. (A) The arrows on the panoramic radiograph depicting calcified stylohyoid ligament bilaterally. (B) The arrow on the panoramic radiograph showing multiple radiopaque masses superimposed on the right mid-ramus region suggestive of tonsilloliths (The contrast of the radiograph is altered for better visualisation of the calcification).

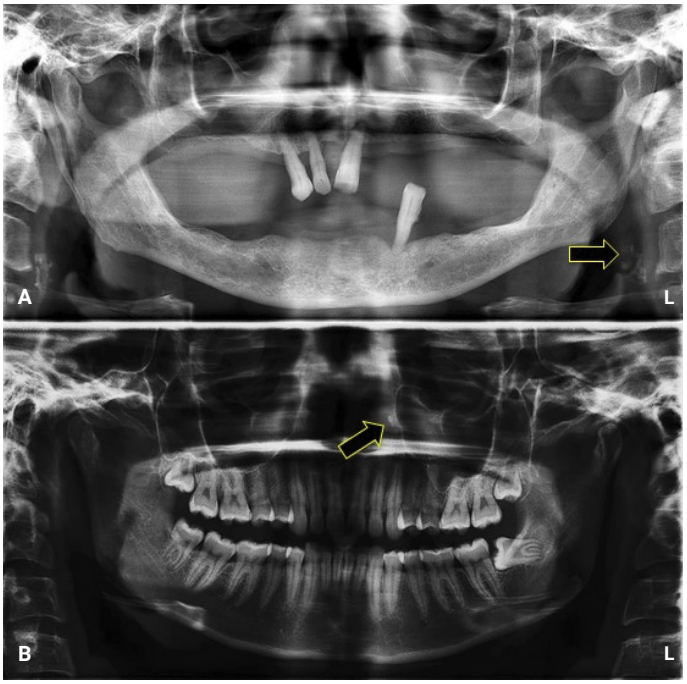

Figure 4. (A) The arrow on the panoramic radiograph showing a well-defined radiopacity with a "cauliflower appearance" near the mandibular angle suggestive of calcified lymph node. (B) The arrow on the panoramic radiograph showing a well-defined radiopacity close to the nasal fossa on left side suggestive of rhinolith (The contrast of the radiograph is altered for better visualisation of the calcification).

statistically significant association of the occurrence of antrolith (p=0.018) among the males and rhinolith (p=0.025) among the females and it was predominantly seen in the young-adult population. We also observed a significant prevalence in the occurrence of tonsillolith (p=0.007) among the males, carotid artery calcifications (p=0.001) and calcified styloid ligament (p=0.022) among the females and was predominantly seen among the middle-aged population respectively (Table-3).

Table 3. Distribution of various soft tissue calcifications based on age group and gender

TYPE OF CALCIFICATION		AGE			p-value
		03-39 (YOUNG ADULTS)	40-59 (MIDDLE AGED)	60-99 (OLD AGED)	
Antrolith	M	6 (100%)	**0**	**0**	**0.018**
	F	4 (57.1%)	3 (42.6%)	**0**	
Rhinolith	M	**0**	1 (20%)	**0**	**0.025**
	F	4 (80%)	**0**	**0**	
Phlebolith	M	11 (50%)	5 (22.7%)	6 (27.3%)	0.111
	F	4 (28.6%)	8 (57.1%)	2 (14.3%)	
Tonsillolith	M	3 (17.7%)	10 (58.8%)	4 (23.5%)	**0.007**
	F	4 (100%)	**0**	**0**	
Sialolith	M	3 (33.3%)	4 (44.4%)	2 (22.2%)	0.513
	F	2 (66.7%)	1 (33.3%)	**0**	
Calcified Lymph Node	M	1 (100%)	**0**	**0**	0.248
	F	1 (33.3%)	**0**	2 (66.6%)	
Carotid artery calcifications	M	12 (80%)	3 (20%)	**0**	**0.001**
	F	8 (14.5%)	35 (63.6%)	12 (21.8%)	
Calcified styloid ligament	M	4 (57.1%)	1 (14.3%)	2 (28.6%)	**0.022**
	F	16 (44.4%)	19 (52.8%)	1 (2.8%)	

Analysis of Soft tissue calcifications based on Site and Gender:

Our results revealed that most of the calcifications occurred on the left side and the prevalence of calcifications on the left and right sides comprised 51.9% and 48% respectively. There was a statistically significant association of occurrence of Tonsillolith in the right side of males (p=0.011). In addition, the occurrence of carotid artery calcification in the left (p=0.011); right (p=0.029) sides and calcified stylohyoid ligament in the left (p=0.041); right (p=0.009) sides in females were found to be statistically significant (Table 4). However, there was no significant difference in the occurrence of antrolith, rhinolith, phlebolith, sialolith, calcified lymph nodes among males and females (p-value > 0.05).

Table 4. Frequency of various soft tissue calcifications based on gender

TYPE OF CALCIFICATION		GENDER		p-value
		MALE	FEMALE	
Antrolith	L	**4** (30.8%)	**4** (30.8%)	0.717
	R	**2** (15.4%)	**3** (23%)	0.401
Rhinolith	L	**1** (20%)	**2** (40%)	0.668
	R	**0**	**2** (40%)	0.167
Phlebolith	L	**12**(33.3%)	**7** (19.4%)	0.806
	R	**10** (27.8%)	**7** (19.4%)	1.0
Tonsillolith	L	**8** (38%)	**4** (19%)	0.762
	R	**9** (42.9%)	**0**	**0.011**
Sialolith	L	**5** (41.7%)	**2** (16.7%)	0.701
	R	**4** (33.3%)	**1** (8.3%)	0.649
Calcified Lymph Node	L	**0**	**1** (25%)	0.410
	R	**1** (25%)	**2** (50%)	0.668
Carotid artery calcifications	L	**7** (10%)	**28** (40%)	**0.011**
	R	**8** (11.4%)	**27** (38.6%)	**0.029**
Calcified styloid ligament	L	**4** (9.3%)	**17** (39.5%)	**0.041**
	R	**3** (6.9%)	**19** (44.2%)	**0.009**

Discussion

Panoramic radiography (OPG) is an imaging modality that can aid in simultaneous preliminary radiographic examination of both maxillary and mandibular jaws. Despite being a two-dimensional radiograph, OPG is one of the frequent radiographic investigations employed in maxillofacial radiology due to its low cost and reduced patient radiation exposure[17]. Thereby, given its popularity, dental clinicians should be familiar with the typical patterns and characteristic radiographic features of various soft-tissue calcifications that are encountered in the maxillofacial region. These calcifications are often asymptomatic and detected as incidental findings[4]. According to the recommendations of the American Academy of Oral and Maxillofacial Radiology, the use of a three-dimensional imaging modality like CBCT, which has the advantage of providing high-quality diagnostic images, cannot be justified in the initial evaluation of soft tissue calcifications unless the patient is symptomatic[18,19].

In our study, we observed soft tissue calcifications in 12.9% of the total radiographs, which is comparatively higher than the reports of previous studies which revealed a prevalence rate varying between 2.6% and 19.7%[3,5,10,20]. This difference in the prevalence can be attributed to several factors such as racial, age, geographical and ethnic variations. Apart from this, the possibility to alter the image density and contrast in the radiographic images can also attribute to the variations as reported by Monsour et al.[20]. We found that the majority of calcifications within the soft tissues were more common in middle-aged (44.1%) population followed by young adults (40.7%). These

findings were consistent with the results of Icoz et al. and Ribeiro et al. who also suggested that the prevalence of calcifications increased above 40 years[4,10]. The process of calcinosis begins at an early age and progresses as the patient ages thus becoming radiographically identifiable.

The most commonly observed soft tissue calcification in the present study was calcification of the carotid artery constituting 4.4% of all included radiographs. The results were statistically significant and were consistent with the findings of Bayer et al., Saati et al. and Garay et al. who reported a higher prevalence of calcifications of carotid artery in the middle-aged female population[3,17,21]. Women were more typically affected in the post-menopausal period (>50 years) owing to the diminished oestrogen levels. The role of oestrogen in the metabolism of lipoproteins is well established in the literature, and it is known to inhibit the formation of atheromatous plaques[4,22]. The link between the risk of ischemic stroke and the occurrence of carotid artery calcifications has been a source of debate. Significant narrowing of an arterial lumen with a lucent defect is indicated by a massive calcification. According to the literature, the calcium levels in cervical carotid arteries serves as an independent marker for the detection of ischemic symptoms[23]. Literature evidences have accounted stroke to be the second-leading cause of death globally (11.6%). Risk of stroke in the presence of atherosclerosis of the carotid artery is 8%. Hence, active observation of the asymptomatic patients with the aid of panoramic radiographs can potentially reduce the occurrence of any life-threatening consequences such as stroke and myocardial infarction[5,10,17,24].

Out of the total radiographs evaluated, our study reported an overall prevalence of 2.7% of calcified stylohyoid ligament. Previous studies have reported varied prevalence rates ranging from 7.9% to 38.57%[5,14,25]. We observed the occurrence of calcified stylohyoid process to be significantly higher in women and predominantly on the right side compared to the left. We also observed an increasing trend in the calcification of the stylohyoid ligament in the middle-aged population which was statistically significant. Our findings are in accordance with the study by Guimarães et al. and Oztas et al., which reported patients above 40 years of age to have higher prevalence of calcification of the stylohyoid complex[26,27]. This could be attributed to the anatomical variations, variability in the muscle stress owing to occlusal interferences and racial differences of the population studied. The stylohyoid ligament was considered to be calcified if the length of the stylohyoid complex exceeded more than 30mm extending from the inferior border of the external acoustic meatus[10]. Till date, there is an absence of a consensus regarding the standard size of this medially angulated ligament[14,17].

OPG is a preferred choice for the evaluation and visualization of the calcified stylohyoid complex which is one of the major etiological factors for Eagle's syndrome[10]. This syndrome which was initially described by Wett Eagle in 1937 is characterized by persistent dull pain in the facial and oropharyngeal region. The affected individuals may present with dysphagia and subjective sensation of a foreign body in the throat accompanied by unexplained headache and increased salivation[28].

In our study, tonsilloliths constituted 1.3% of the total included radiographs. Our findings can be matched with the reports by Garay et al. and Ribeiro et al. who reported

prevalence rates of 1.4% and 0.9% respectively[3,10]. Occurrence of tonsilloliths in the right side were significant in males which is consistent with the findings reported by Saati et al.[17]. In addition, we observed a significant association of tonsillolith with age, as majority of these calcifications were seen in individuals above the age of 40. Garay et al.[3] in their study have also reported similar findings. Often, these small concretions are asymptomatic and are detected incidentally on panoramic radiographs[29]. However, the presence of these calcifications in a relatively larger size may cause difficulty in swallowing, reflex otalgia, odynophagia, halitosis and may predispose to peritonsillar abscess due to superinfection[30].

The prevalence of antrolith, observed in our study was 0.8% and most of them were found on the left side. Rhinoliths were observed in 0.3% of the total radiographs studied and was more frequent on the left side. In our study, the occurrence of antroliths was more in the young-adult males and rhinoliths in the young-adult females. These results were found to be significant and was similar to the findings of Ribeiro et al.[10]. In most individuals, calcifications in the antrum or nasal cavity may not cause any clinical symptoms. Occasionally, such calcifications can cause facial pain, epistaxis, epiphora, perforation of the mucosa[16,31].

Of the total radiographs studied, 36 (2.3%) of the radiopacities represented the characteristic features of phleboliths, which are the calcifications of the venous system. Similar findings were reported by Saati et al. who observed a prevalence rate of 0.29% of phleboliths[17]. In the present study, 0.7% of sialoliths and 0.2% of calcified lymph nodes were observed on the radiographs. According to the findings of Ayranci et al.[32], calcification of the salivary glands is known to affect one in every 10,000 to one in every 30,000 individuals. These calcifications may obstruct the ductal flow causing acute pain that intensifies with meals. The understanding of various calcifications occurring in the maxillofacial region is necessary to aid in their diagnosis and to predict their possible consequences, which could be beneficial for patients.

The present study has certain inherent limitations of cross-sectional studies like the inability to acquire the entire medical history of the patient. There exists a lack of consensus in the standardization of criteria for analysing soft tissue calcifications in the panoramic radiographs.

Further, better-designed multi-centric prospective studies using three-dimensional radiographic modalities focusing on long-term follow-up are necessary to define the typical radiographic appearances of specific calcifications and to describe their clinical effects on symptomatic and asymptomatic patients. Such future researches would not only provide more relevant information to an individual's medical care but also permits an accurate referral so as to prevent any potential morbidities.

In conclusion, the present study emphasizes the radiographic appearances of various soft tissue calcifications occurring in the maxillofacial region, so as to aid in a better diagnosis. We found the soft tissue calcifications to be more predominant in women with increased occurrences over 40 years of age. Optimal knowledge of the normal anatomy of the maxillofacial skeleton is inevitable to arrive at a precise radiographic diagnosis of such calcifications.

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Conflicts of interest

None.

Data availability

Datasets related to this article will be available upon request to the corresponding author.

Author Contribution

Deepthi Darwin: Methodology, Investigation, Writing – original draft preparation, review and editing.

Renita Lorina Castelino: Conceptualization, Methodology, Formal analysis, Validation.

Gogineni Subhas Babu: Conceptualization, Resources, Validation.

Mohamed Faizal Asan: Writing – review and supervision, Investigation, Visualization.

All authors actively participated in the discussion of the manuscript's finding, revised and approved the final version of the manuscript.

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