DOI: 10.37990/medr.1631064 Med Records 2025;7(2):384-92

MEDICAL RECORDS-International Medical Journal

Research Article

A Comparative Study Evaluating Tonsillolith and Stylohyoid Ligament Ossification on Cone Beam Computed Tomography and Panoramic Radiography: A Retrospective Study

Halil Ayyildiz, Arif Turkoglu

Kütahya Health Sciences University, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology, Kütahya, Türkiye

Abstract

Aim: Dentists frequently encounter soft tissue calcifications in their routine practice. Stylohyoid ligament calcification or ossification (SHLO) is a common incidental finding on radiographs. Tonsillolith is a calcified structure formed as a result of chronic and recurrent inflammation in the crypts of the tonsils. The purpose of this study was to compare the prevalence of tonsillolith and SHLO and mean length oh SHL obtained using cone beam computed tomography (CBCT) and panoramic radiography (PR) images.

Material and Method: In this study, CBCT and PR images of a total of 289 patients (mean age 41.87 years), including 157 females and 132 males, were evaluated. The prevalence of tonsilloliths and SHLO was recorded as present/absent, and SHL lengths were measured as the linear distance between the base and the apex of the stylohyoid process on CBCT and PR images. The SHL lengths greater than 30 mm were labeled as SHLO and used in the prevalence statistics. Wilcoxon test used for the relationship between SHL/SHLO lengths obtained by two different imaging methods and McNemar test for the prevalence of tonsillolith obtained by two different imaging methods.

Results: The prevalence of tonsillolith was found to be 7.4% with PR and 23.5% with CBCT, the prevalence of SHLO was 34.78% with PR and 43.25% with CBCT, and the mean SHL length was 28.67 mm with PR and 30.88 mm with CBCT. The prevalence of SHLO and tonsillolith was found to be higher in CBCT than in PR, and the measured mean SHL length was greater. This difference was statistically significant. No statistically significant differences were observed between genders with respect to SHL length and SHLO prevalence. The prevalence of tonsillolith in males was found to be statistically significantly higher than in females.

Conclusion: In cases where the length of the SHL is of critical importance for SHLO or when there is a suspicion of Eagle syndrome, CBCT is more suitable imaging technique instead of PR. This is also the case for tonsillolith evaluations, as the CBCT eliminates superimpositions.

Keywords: Cone-beam computed tomography, heterotopic ossification, palatine tonsil, panoramic radiography

INTRODUCTION

Dentists frequently encounter soft tissue calcifications (STC) in their routine practice. The majority of STC cases are asymptomatic and identified as incidental findings on radiographic images (1). Calcium salt accumulation in soft tissue that lacks organization is classified as heterotopic calcification, whereas organized calcium salt accumulation is defined as heterotopic ossification. Heterotopic calcification is classified into three categories: dystrophic, idiopathic, and metastatic. These categories are based on the mechanism, etiology, and localization of the calcification (2). Dystrophic calcification represents a specific form of heterotopic calcification observed in degenerate, diseased, or dead tissues of individuals who have normal levels of calcium and phosphate in their serum (3). It frequently manifests following inflammatory, traumatic, or infectious processes (4). These calcifications are found primarily in the area of the head and neck. They are relatively common in the general population. Most calcifications are asymptomatic and are incidentally identified through imaging techniques commonly employed in dentistry (2).

CITATION
Ayyildiz H, Turkoglu A. A Comparative Study Evaluating Tonsillolith and Stylohyoid Ligament Ossification on Cone Beam Computed Tomography and Panoramic Radiography: A Retrospective Study. Med Records. 2025;7(2):384-92. DOI:1037990/medr.1631064

Received: 01.02.2025 **Accepted:** 03.03.2025 **Published:** 08.05.2025

Corresponding Author: Halil Ayyildiz, Kütahya Health Sciences University, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology, Kütahya, Türkiye
E-mail: halil.ayyildiz@ksbu.edu.tr

Styloid process is a pointed and cylindrical bone process. It originates from the inferior aspect of the petrous part of the temporal bone, moving in an antero-inferior direction. The inferior part of the styloid process close to the carotid vessels (5,6). Stylohyoid ligament, originates from the styloid process and connects the temporal and hyoid bones (5). Stylohyoid ligament calcification or ossification (SHLO) is a common incidental finding on radiographs (1,7). A length of 30 mm or more is considered calcified/elongated (6,8,9). Eagle syndrome, which is characterized by elongation of this ligament, is associated with some symptoms (10). Pain can be felt in the throat, front of the neck and ear. The view of SHLO is not pathognomonic for Eagle syndrome. Symptoms of Eagle syndrome can vary from mild discomfort to acute neurological and reflected pain (11). SHLO; in the region between the posterior aspect of the ramus mandible and the cervical vertebra, there is a radiopaque image in a structure similar to a dry tree branch, which becomes thinner as it moves downward (12).

Tonsilloliths are calcified structures formed in the crypts of the tonsil due to chronic recurrent inflammation (13). On clinical examination, it is usually apparent as yellowish plaques on the tonsillar surface. While smaller tonsilloliths are usually symptomless, bigger ones can cause a variety of symptoms. These include pain, bad breath, foreign body sensation, earaches, irritation, difficulty swallowing, bad taste (14). They can be single or several, one-sided or both-sided. The size of the tonsilloliths can vary from a few millimeters up to several centimeters in size. Tonsilloliths can be seen on routine panoramic radiographs (PR). In the PR images, it is seen in the form of single or multiple radiopacities superimposed on the middle part of the mandibular ramus. Tonsilloliths appear lateral to the oropharyngeal airway on cone beam computed tomography (CBCT) axial sections. Their density is similar to that of cortical bone (15).

Although these calcifications are visible on PR, that is one of the traditional imaging modalities commonly used in dentistry, it has some limitations compared to CBCT (15). The proximity of anatomical structures in the head and neck region leads to distortion, magnification, superimposition and ghost images in the radiographic images. These limitations in PR can lead to inadequate diagnosis and detection of calcifications. With CBCT, the diagnosis and location of the calcification can be accurately determined due to the three-dimensional imaging (16,17).

In cases where STCs are close to bone, it may be difficult to determine whether the calcification is in bone or soft tissue. In such cases, patient history, clinical examination, radiographs taken from a different angle, or other imaging modalities may be useful (2). Today, CBCT is widely used in maxillofacial imaging because of its lower radiation dose and high spatial resolution of bone structures compared to computed tomography (CT). Incidental findings such as STCs can be diagnosed with CBCT (16). The localization, number, shape and distribution of STCs should be considered for correct diagnosis. Knowledge of soft tissue anatomy is necessary for the diagnosis of calcifications (18).

The purpose of this study was to compare the prevalence of tonsillolith and SHLO and mean length oh SHL obtained using CBCT and PR images. In addition, it was also aimed to examine the relationship between the prevalence of tonsillolith and mean length of SHL/SHLO and the age groups and the gender.

MATERIAL AND METHOD

This study designed as retrospective radiological study and received ethical approval from Kütahya University Non-Interventional Clinical Research Ethics Committee with protocol number 2024/05-14 dated April 22, 2024. A total of 795 CBCT images from the image archive of the Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Kütahya Health Sciences University, were examined between January 1, 2022 and January 1, 2023, and the dates of the CBCT's were recorded. The radiographic images of patients who obtained CBCT and PRs within the same week were included in the study. All PRs were acquired using the Morita Veraview EPOCS 2D (Japan) unit at 65-90 kVp and 6-10 mA. Instrumentarium brand device was used to acquire all CBCT images (Palo Dex Group Oy Nahkelantie 160 FI-04300 TUUSULA, FINLAND) using 89 kVp, 4-12 mA values. OnDemand 3D Dental (Cybermed, Seul, South Korea) imaging software used for CBCT measurements. The measurements on the PR were performed using TRtek Medical software (İstanbul, Türkiye). Acer Veriton VZ4880G monitor (23.8-inch, 1920 X 1080 resolution) used for CBCT and PR image evaluations.

Inclusion and Exclusion Criteria

The CBCT images with an 8*15 cm field of view (FOV), where the entire length of the SHL can be seen, were included in the study. Patients without bone metabolic disorders, over 18 years of age, with PR and CBCT images obtained in the same week were included in the present study. Patients in which the entire SHL could not be observed, patients with bone metabolism diseases and patients under the age of 18 were excluded from the study. Furthermore, radiographs with motion artefacts and poor diagnostic quality were excluded.

A priori power analysis with a 5% significance level and an estimated effect size of 0.33, along with a desired study power of 95%, indicated that a minimum number of 262 patients would be required for this investigation (G*Power: Statistical Power Analyses for Windows; Dusseldorf, Germany). A total of 795 CBCTs were analyzed in the present study. Of these, 483 were excluded from the study because they lacked a comparable PR image captured within the same week, 15 were excluded since they were radiographic images of individuals under 18 years of age, and 8 were excluded due to the presence of radiographic artifacts. The final analysis included 289 CBCT and PR images. The study's flow chart is presented in Figure 1.

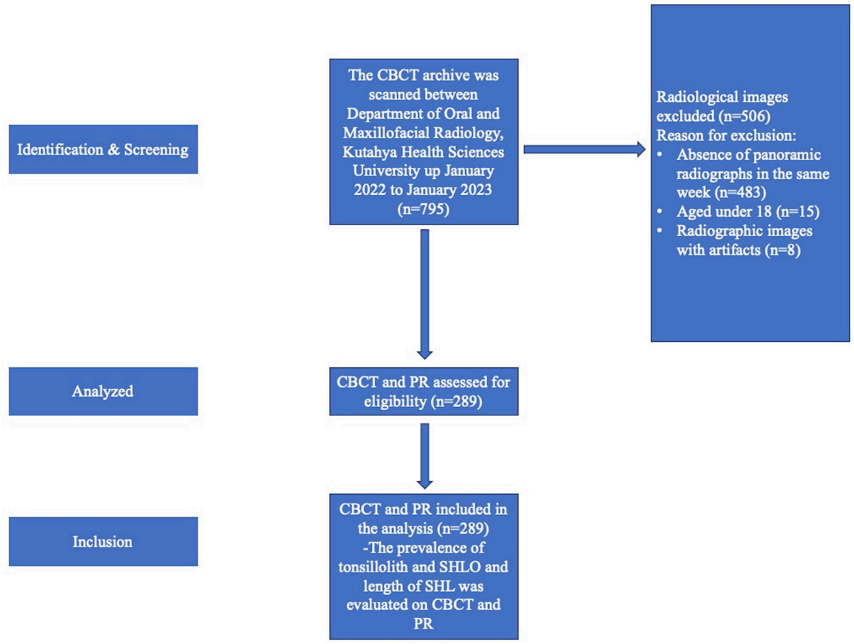

Figure 1. Study flowchart

Evaluations and Measurements on PR and CBCTs

An Oral and Maxillofacial Radiology specialist (A.T.) with three years of experience, in a quiet room with low-level lighting, performed all measurements and evaluations. Measurements and evaluations were repeated twice at two weeks interval. For STCs seen on PR images (Figure 2) (19), only tonsillolith and SHLO were examined. For the prevalence of tonsilloliths, tonsilloliths were labeled as presence/absence.

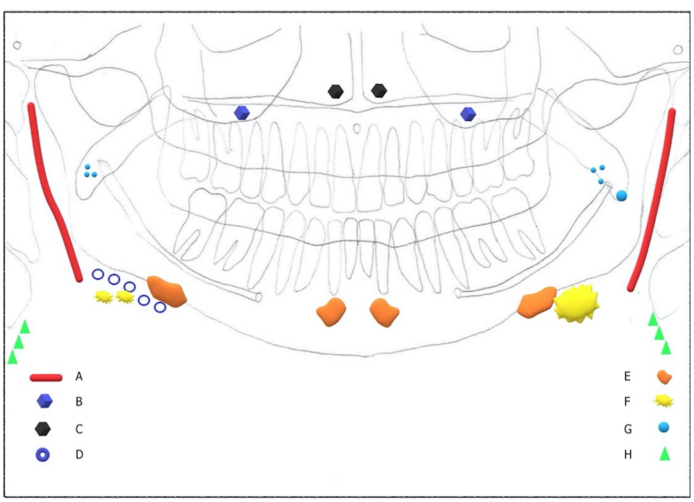

Figure 2. Soft tissue calcifications; A: Stylohyoid ligament ossification, B: Antrolith, C: Rhinolith, D: Phlebolith, E: Sialolith, F: Calcified lymph node, G: Tonsillolith, H: Carotid artery calcification

Detection of Tonsilloliths on CBCT and PR: Tonsilloliths appear as single or multiple radiopacities superimposed on the midsection of the mandibular ramus in PRs, particularly in the region where the dorsal surface of the tongue crosses the oropharyngeal airways (15) (Figure 2). In axial section of CBCT images, tonsilloliths are identified in the soft tissue adjacent to the medial aspect of the mandibular ramus and the lateral wall of the oropharyngeal airway (15) (Figure 3).

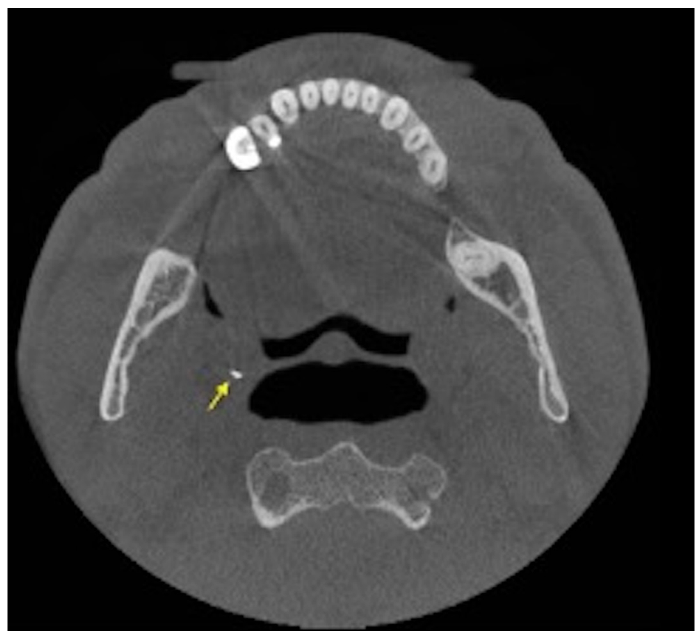

Figure 3. Tonsillolith on axial section of CBCT

Detection and Measurement of SHL on CBCT and PR: In PRs, SHL originates from the region of the mastoid process, extending through the posteroinferior aspect of the mandibular ramus towards the hyoid bone (15). SHL was measured as the linear distance between the base and the apex of the stylohyoid process on PR (8) (Figure 4). The SHL length was determined by measuring the straight-line distance between the base and the apex of the stylohyoid process on CBCT images (8) (Figure 5). The measurement was made including the non-ossified parts of the SHL. Parasagittal sections were used for SHL measurements on the CBCT image. All SHL measurements were recorded in mm. The SHL lengths greater than 30 mm were labeled as SHLO and used in the prevalence statistics. Age, gender information of the patients was added to the Excel table.

Figure 4. SHL measurement on PR

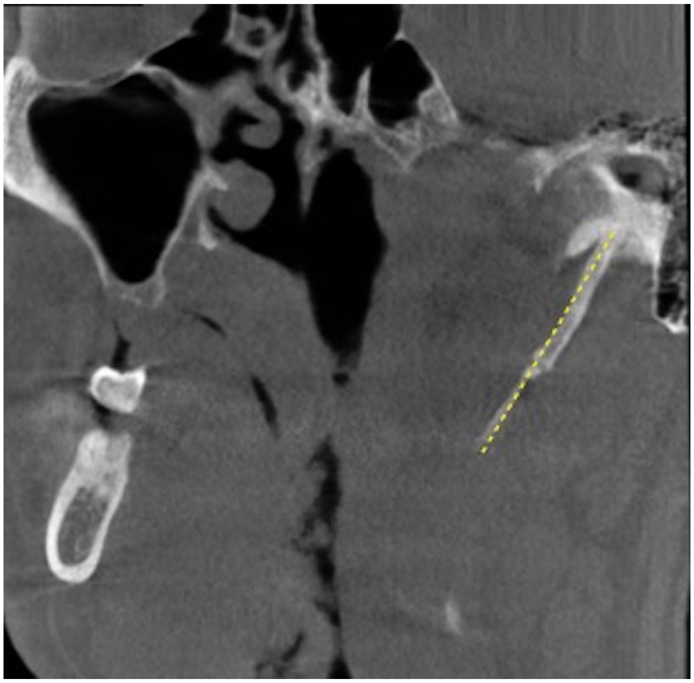

Figure 5. SHL measurement on parasagittal section of CBCT

Statistical Analysis

SPSS software (IBM, SPSS version 26, for Mac, Chicago, IL) was used to investigate the results of this conducted study. Intraclass correlation was used for measurement data, and Goodman-Kruskal tau coefficient was used for categorical data to evaluate intra-observer agreement. Frequency and descriptive statistics were used for all data. Pearson chi-square test was used to analyze the relationship between tonsillolith with age groups and gender. The Mann-Whitney U test was used to compare the means of two independent groups when the measurement data did not meet the requirements of the parametric test; the Kruskal-Wallis test was used to compare the means of three independent groups. The relationship between the measurement data obtained with two different imaging techniques was analyzed by Wilcoxon test, while the categorical data analyzed by using McNemar test. In statistical analyses, significance level was determined as 5%.

RESULTS

Intraclass agreement test results were good for SHL length measurements (0.823) and excellent for tonsillolith scores (0.973). Second measurements were used for further statistical analysis. A total of 289 patients, 157 females and 132 males, were included in our study. The age of the patients included in our study ranged from 18 to 80 years (mean age 41.87 years). The prevalence of tonsilloliths and SHLO was evaluated on 578 sides, and the length of the SHL was measured on 578 sides. To evaluate the relationship between calcifications and age groups, patients were classified into 3 groups according to age. Patients aged 18-35 years were formed the first group, 35-52 years the second group, and 52-80 years the third group. There were 103 patients in the first group, 98 in the second group, and 88 in the third group.

The prevalence of tonsillolith and SHLO, the soft tissue calcifications examined in our study, are shown in Table 1. The prevalence of tonsillolith and SHLO was found to be higher in the CBCT than in the PR. Table 2 presents the mean, minimum, maximum, and standard deviation values for the lengths of SHL and SHLO. The results of our study indicate that the mean SHL length measured with CBCT was 30.88 mm, while with PR it was 28.67 mm. Additionally, the mean SHLO length was measured as 38.44 mm with CBCT and 37.43 mm with PR.

Table 1. Prevalence of STCs on CBCT and PR

Imaging techniques	Soft tissue calcifications	Presence		Absence	
		n	%	n	%
CBCT	Tonsillolith	136	23.5	442	76.5
	SHLO	250	43.25	328	56.75
PR	Tonsillolith	43	7.4	535	92.6
	SHLO	201	34.78	377	65.22

Table 2. Descriptive analysis of SHL and SHLO on CBCT and PR

Imaging techniques	Length	n	Mean	Minimum	Maximum	Standard deviation
CBCT	SHL	578	30.88	7.10	92.45	9.34
	SHLO	250	38.44	30.19	92.45	9.10
PR	SHL	578	28.67	9.12	84.82	8.74
	SHLO	201	37.43	30.11	84.82	8.51

In our study, tonsilloliths were observed statistically significantly more often in males in both PR and CBCT images. They were also observed statistically significantly less frequently in the patient group under 35 years of age than in the other patient groups in both imaging techniques. There was no statistically significant relationship between the second and third age groups (Table 3).

Table 3. Relationship between prevalence of tonsillolith and SHLO with gender and age groups

Soft tissue calcifications	Demographic data	Imaging techniques		n		p value
				Presence (%)	Absence (%)	
Tonsillolith	Gender	CBCT	Female	255 (81.2)	59 (18.8)	0.003*
			Male	187 (70.8)	77 (29.2)	
		PR	Female	297 (94.6)	17 (5.4)	0.043*
			Male	238 (90.2)	26 (9.8)	
	Age groups	CBCT	18-35[a]	179 (86.9)	27 (13.1)	0.000*
			35-52[b]	144 (73.5)	52 (26.5)	
			52-80[b]	119 (67.6)	57 (32.4)	
		PR	18-35[a]	201 (97.6)	5 (2.4)	0.002*
			35-52[b]	178 (90.8)	18 (9.2)	
			52-80[b]	156 (88.6)	20 (11.4)	
SHLO	Gender	CBCT	Female	183 (58.3)	131 (41.7)	0.417
			Male	145 (54.9)	119 (45.1)	
		PR	Female	215 (68.5)	99 (31.5)	0.074
			Male	162 (61.4)	102 (38.6)	
	Age groups	CBCT	18-35[a]	131 (63.6)	75 (36.4)	0.006*
			35-52[b]	94 (47.9)	102 (52.1)	
			52-80[b]	103 (58.5)	73 (41.5)	
		PR	18-35[a]	156 (75.7)	50 (24.3)	0.000*
			35-52[b]	110 (56.1)	86 (43.9)	
			52-80[b]	111 (63.1)	65 (36.9)	

Pearson chi-square test was used; *p<0.05 was considered statistically significant; There is no statistically significant difference between groups with the same superscripts

Table 4 shows the relationship between mean SHL and SHLO lengths with gender, and age groups. While there was no statistical relationship between mean SHL length and gender, the relationship between mean SHLO length and gender was significant. Male patients with SHLO had longer SHLO lengths than females.

The relationship between SHL length and age group was statistically significant. Accordingly, the mean SHL length of the patient group under 35 years of age was lower than the other groups in both imaging techniques. The relationship between mean SHLO length and age groups was not statistically significant (Table 4).

Table 4. Relationship between SHL and SHLO lengths with gender and age groups

Soft tissue calcifications	Demographic data	Imaging techniques		n	Mean (mm)	p^1 value	p^2 value
SHL Length	Gender	CBCT	Female	314	29.84	0.126	-
			Male	264	32.10		
		PR	Female	314	27.75	0.155	-
			Male	264	29.77		
	Age groups	CBCT	18-35[a]	206	29.99	-	0.010*
			35-52[b]	196	31.60		
			52-80[b]	176	31.13		
		PR	18-35[a]	206	27.27	-	0.000*
			35-52[b]	196	29.31		
			52-80[b]	176	29.60		
SHLO Length	Gender	CBCT	Female	131	36.40	0.000*	-
			Male	119	40.70		
		PR	Female	99	35.54	0.002*	-
			Male	102	39.27		
	Age groups	CBCT	18-35	75	39.12	-	0.376
			35-52	102	37.48		
			52-80	73	39.12		
		PR	18-35	50	39.26	-	0.131
			35-52	86	36.23		
			52-80	65	37.63		

p^1: Mann Whitney-U test was used, p^2: Kruskal-Wallis test was used, * p<0.05 was considered statistically significant; There is no statistically significant difference between groups with the same superscripts

The comparison of the prevalence of tonsillolith and the length of SHL in CBCT and PRs is shown in Table 5. The diagnosis of tonsillolith was found to be statistically significantly higher in CBCT than in PRs. The mean SHL length was found to be statistically significantly higher in CBCT than in PR (Table 5).

Table 5. Comparison of tonsillolith prevalence and SHL length with CBCT and PR

	Imaging Techniques	Tonsillolit		P[1]	SHL	P[2]
		Presence (n, %)	Absence (n, %)		Mean (mm)	
Right	CBCT	74 (25.6)	215 (74.4)	0.000*	31.17	0.000*
	PR	21 (7.3)	268 (92.7)		28.85	
Left	CBCT	62 (21.4)	227 (78.6)	0.000*	30.59	0.000*
	PR	22 (7.6)	267 (92.4)		28.49	
Total	CBCT	136 (23.5)	442 (76.5)	0.000*	30.88	0.000*
	PR	43 (7.4)	535 (92.6)		28.67	

p[1]: McNemar test was used, p[2]: Wilcoxon test was used, * $p<0.05$ was considered statistically significant

DISCUSSION

In PRs, structures situated medially concerning the focal trough are subject to higher magnification and distortion. The SHL, particularly its distal end, is situated in a medial position relative to the image layer (5). CBCT imaging is a more effective modality for examining the SHL than PR (20). The orientation of the SHC and its relationship with adjacent anatomical structures can be more accurately assessed on three-dimensional radiographs than on two-dimensional radiographs (21).

The differential diagnosis of tonsilloliths includes pathologies such as osteosclerosis, enostosis, sialolithiasis, lymph node calcification, and phleboliths. When complemented by a CT screening, PR is an effective method for diagnosing these lesions. The use of CBCT images from both sides of the jaw is beneficial for the precise determination of the locations of these calcifications (12,22). Accurate diagnosis of SHLO on PRs can sometimes be difficult due to superimposition of adjacent bony structures. CT overcomes this problem and provides reliable visualization of SHLO features and their relationship to the surrounding anatomy (20).

Tonsilloliths are described in the literature as incidental findings on PRs, but the limitations of this technique make interpretation difficult. In the existing literature, some articles report the prevalence of tonsillolith on panoramic images to be between 2.5% and 18% (22-26). Our study yielded a prevalence rate of 7.4%. Nevertheless, the discrepancy between the prevalence figures reported in some studies was more pronounced (22,23). The discrepancy between studies is thought to be due to differences in the number of samples analyzed. A review of the literature revealed that the prevalence of tonsillolith in studies conducted with CBCT ranged from 2% to 33.2% (27-31). The prevalence of tonsillolith detected in panoramic images was 23.5%. This value was in the range of literature values. This range was generally higher than that observed in PRs. This discrepancy may be due to the fact that CBCT does not produce superposition and creates higher resolution images compared to PR. A number of factors, including sample size, inter-individual variability among patients within a given sample, and differences in the field of view (FOV) of CBCTs, may account for the considerable variation in the prevalence of tonsilloliths observed in CBCT studies.

In addition to studies that report a statistically higher prevalence of tonsillolith in males (2,22), there are also studies that report a statistically higher prevalence of tonsillolith in females (25). Additionally, in some studies have shown that there is no statistical difference between them (26-28). The prevalence of tonsillolith significantly higher in the male population in the course of our study. The difference in findings may be due to the impact of individual variables, like the presence of tonsillolith, which in some cases may have gone undiagnosed and untreated.

The precise etiology and pathogenesis of tonsillolith are unknown, but repeated flare-ups of inflammation may lead to dystrophic calcification of the tonsil crypts. It is believed that the likelihood of developing this dystrophic calcification increases with increasing age. In the present study, the relationship between age groups and the incidence of tonsillolith showed statistical significance. According to this relationship, tonsillolith increased with age. There are a number of studies in the literature that are in agreement with this outcome (25,27,32). However, there are also inconsistent studies (26,28,31). This difference is likely due to differences in mean age between study populations.

The styloid ligament ossification typically appears as a thin bony prominence that originates from the styloid process and extends toward, and sometimes contacts, the lesser horn of the hyoid bone. In studies conducted with the use of PR, the prevalence of SHLO has been documented to range between 6.23% and 83.6% (33-35). The SHLO observed in the present study exhibited a prevalence rate of 34.78%, which is consistent with the aforementioned range. The principal reason for this extensive discrepancy in the literature is believed to be the size of the sample population. As the number of samples included in these reviewed articles increased, so also did the prevalence of SHLO. Furthermore, the prevalence of SHLO has been reported to be between 3.14% and 63% in studies conducted with CBCT (27-29,36). The frequency of SHLO observed in this present study was within the above range, occurring in 43.25% of cases. The reason for this wide range of prevalence in the literature may be due to the varying field of view of CBCT, sample size, and individual differences of the patients included in the sample.

The accepted upper limit for the normal length of SHL is 30 mm, as evidenced in the literature (34). In our study, the mean SHL length measured by PR was 28.67 mm, while the mean SHLO length was 37.43 mm (6,33,34). The outcomes obtained from panoramic images were slightly higher to that of the studies employing PR. In the study conducted by Okabe et al. (37), the mean SHL length was found to be 36.7 mm, which is greater than the outcome of the current study. The inclusion of PRs of only 80-year-old patients in their study may explain this disparity (37).

The mean SHL length measured by CBCT was 30.88 mm, while the mean SHLO length was 38.45mm. As reported by Al-Amad et al. in their CBCT study, the mean SHL length was found to be 30.2 mm on the right and 31.2 mm on the left (7). The mean SHL length observed in our study is similar to that reported in the aforementioned study (31.17 mm on the right and 30.59 mm on the left). In the CBCT studies conducted by Büyük et al. (38) and Andrei et al. (5), the mean SHL was found to be 35.09 and 34.28 mm, respectively. These results were higher than those observed in our study. In a study employing the same imaging technique, İlgüy et al. (39) observed an average SHL length of 25.3 mm. This result differed from our study's, yielding a smaller value. The discrepancies may be attributed to the higher mean age or the different sample sizes.

Conflicting results exist in the literature regarding the relationship between SHLO frequency and SHL length with gender. Some studies have found that the SHL length is statistically significantly greater in males than in females (5,33,37). Additionally, some studies did not find a statistical significance between gender and SHL length (38,39). SHLO frequency was observed to be statistically significantly higher in males than females (28). Conversely, some studies reported no statistically significant relationship between gender and SHLO frequency (7,20), or more SHLO frequency in females (35). In the present study, SHL length and SHLO frequency were not statistically related to gender. It is reported that surgical trauma, local chronic irritation, retention of mesenchymal elements, menopausal endocrine disorders and trauma or mechanical stress during growth may lead to SHL hyperplasia in the literature (40). The lack of knowledge regarding the etiological factors in the patients included in our study may explain this discrepancy. In our study, the relationship between SHLO length and gender was also investigated. The SHLO length was higher in males than in females. Missias et al. (28) came to same conclusion.

Although previous studies have indicated that the correlation between SHLO prevalence and age groups is not statistically significant (9,20,28,35), another research has demonstrated that there is, a statistically significant relationship between the two (33). Our study found that SHLO frequency was significantly lower in patients under 35 years of age than in other age groups. İlgüy et al. (39) and Büyük et al. (5), who examined the relationship between SHL length and age groups, found no statistical relationship. In our study, the relationship was found to be statistically significant. The mean SHL lengths of patients under the age of 35 were observed to be lower than those in the other age groups over the age of 35. The discrepancy may be attributable to the difference in age groups represented in the studies. In the present study, the relationship between mean ossified SHL lengths and age groups was also investigated. No statistically significant relationship was identified.

Panoramic imaging is an easily accessible method of imaging that uses a low dose of radiation and is used in the majority of dental procedures (22). But the diagnostic limitations of PRs make the identification of soft tissue calcifications challenging (20). In a study conducted by Özdede et al. (31), the detection of tonsilloliths in PR and CBCT was compared. In this study, some tonsilloliths identified in CBCT were not visible in PR. The number of tonsilloliths detected in PR was found to be statistically significantly lower than that detected by CBCT. In a comparative study conducted by Gökçen et al. (8), where PR and CBCT were used, the frequency of elongated SHL was found to be statistically significantly higher in CBCT. In a study conducted by Centurion et al. (20), the tonsillolith and SHL chain were evaluated using PR and CBCT. In their study, the prevalence of tonsilloliths and SHLO detected with PR was found to be statistically lower than that with CBCT. In our study, the prevalence of tonsilloliths was found to be higher in CBCT images, and the mean length of SHL was observed to be longer, in alignment with the findings of the aforementioned studies. The lower results obtained in PR are believed to be attributable to the intrinsic characteristics of the imaging modality, including superposition, magnification, and distortion of the image, as well as the reduction of three-dimensional structures to two dimensions. Furthermore, the detectability of calcifications in PR may be influenced by several factors, including the size of the calcification, the degree of calcification, and individual differences such as bone density.

A limitation of this study was the absence of data regarding tonsillolith size. As a result, an examination of the relationship between the prevalence of tonsilloliths detected by PRs and tonsillolith sizes was not possible. Another limitation of our study is the uncertainty regarding the presence or absence of a history of micro or macro trauma in the included patients, as well as the lack of information concerning the menopausal status of female patients. It is recommended that these factors be taken into consideration in future studies.

CONCLUSION

In conclusion, In the literature, the prevalence, size, and relationship with demographic data of tonsillolith and SHLO have been evaluated with different imaging methods such as PRs, CBCT, and CT; however, comparative studies with PR and CBCT are limited. The prevalence of tonsillolith and

SHLO, as well as the length of SHL, were found to be higher in CBCT images in our study. Furthermore, the occurrence of tonsilloliths and SHL was found to be statistically associated with age groups. The statistical analysis revealed that males had higher tonsillolith prevalence and the mean SHL length. The use of CBCT images as an imaging technique for the detection of these pathologies is more suitable than that of PR, due to the superiority of the imaging features of CBCT images over those of PR. The use of panoramic imaging in the initial assessment, epidemiological evaluation, and screening of calcifications may assist in diagnosing and monitoring these conditions. In circumstances where an accurate measurement of the length of the SHL is crucial for the diagnosis of SHLO or when there is a suspicion of Eagle syndrome, a CBCT evaluation should be conducted instead of a PR. In cases where the length of the SHL is of critical importance for SHLO or when there is a suspicion of Eagle syndrome, CBCT is more suitable imaging technique instead of PR. This is also the case for tonsillolith evaluations, as the CBCT eliminates superimpositions.

Financial disclosures: *The authors declared that this study has received no financial support.*

Conflict of interest: *The authors have no conflicts of interest to declare.*

Ethical approval: *The research protocol was approved by Kütahya Health Sciences University Non-Interventional Clinical Research Ethics Committee (decision date and approval number: 22.04.2024, 2024/05-14). All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration. Since our research is a retrospective study, the informed consent form has not been taken.*

REFERENCES

1. Syed AZ. Soft tissue calcifications in the head and neck region. Dent Clin North Am. 2024;68:375-91.
2. Yalcin ED, Ararat E. Prevalence of soft tissue calcifications in the head and neck region: a cone-beam computed tomography study. Niger J Clin Pract. 2020;23:759-63.
3. Scarfe WC, Farman A. Soft tissue calcifications in the neck: Maxillofacial CBCT presentation and significance. AADMRT Currents. 2010;2.2:3-15.
4. de Oliveira Cde N, Amaral TM, Abdo EN, Mesquita RA. Bilateral tonsilloliths and calcified carotid atheromas: case report and literature review. J Craniomaxillofac Surg. 2013;41:179-82.
5. Buyuk C, Gunduz K, Avsever H. Morphological assessment of the stylohyoid complex variations with cone beam computed tomography in a Turkish population. Folia Morphol (Warsz). 2018;77:79-89.
6. Hettiarachchi PVKS, Jayasinghe RM, Fonseka MC, et al. Evaluation of the styloid process in a Sri Lankan population using digital panoramic radiographs. J Oral Biol Craniofac Res. 2019;9:73-6.
7. Al-Amad SH, Al Bayatti S, Alshamsi HA. Stylohyoid ligament calcification and its association with dental diseases. Int Dent J. 2023;73:151-6.
8. Akçiçek G, Kara D, Uysal S, Zengin HY. Comparison of elongation and calcification patterns of styloid process on panoramic and cone beam computed tomography images. European Annals of Dental Sciences. 2023;50:S1-5.
9. Saati S, Foroozandeh M, Alafchi B. Radiographic characteristics of soft tissue calcification on digital panoramic images. Pesquisa Brasileira em Odontopediatria e Clínica Integrada. 2020;20:e5053.
10. Dey A, Mukherji S. Eagle's syndrome: a diagnostic challenge and surgical dilemma. J Maxillofac Oral Surg. 2022;21:692-6.
11. Badhey A, Jategaonkar A, Anglin Kovacs AJ et al. Eagle syndrome: a comprehensive review. Clin Neurol Neurosurg. 2017;159:34-8.
12. Çitir M, Gündüz K. The prevelance of soft tissue calcification/ossification on panoramic radiography. Selcuk Dent J. 2020;7:226-32.
13. de Moura MD, Madureira DF, Noman-Ferreira LC, et al. Tonsillolith: a report of three clinical cases. Med Oral Patol Oral Cir Bucal. 2007;12:E130-3.
14. Babu BB, Tejasvi MLA, Avinash CK, B C. Tonsillolith: a panoramic radiograph presentation. J Clin Diagn Res. 2013;7:2378-9.
15. Carter LC. Yumuşak doku kalsifikasyon ve ossifikasyonları. In: White SC, Pharoah MJ, eds. Oral radyoloji ilkeler ve yorumlama. 7 edition. Ankara: Palme Yayınevi; 2018;524-41.
16. Scarfe WC, Farman AG, Sukovic P. Clinical applications of cone-beam computed tomography in dental practice. J Can Dent Assoc. 2006;72:75-80.
17. Mısırlıoglu M, Nalcaci R, Adisen MZ, Yardımcı S. Bilateral and pseudobilateral tonsilloliths: three dimensional imaging with cone-beam computed tomography. Imaging Sci Dent. 2013;43:163-9.
18. Duran MH, Coşgun Baybars S. Evaluation of soft tissue calcifications in the head and neck region on panoramic radiography of edentulous patients. NEU Dent J. 2024;6:208-15.
19. Avsever H, Orhan K. Çene kemiği ve çevre dokuları etkileyen kalsifikasyonlar. Turkiye Klinikleri J Oral Maxillofac Radiol-Special Topics. 2018;4:43-52.
20. Centurion BS, Imada TS, Pagin O, et al. How to assess tonsilloliths and styloid chain ossifications on cone beam computed tomography images. Oral Dis. 2013;19:473-8.
21. Gayathri G, Elavenil P, Sasikala B, et al. 'Stylo-mandibular complex' fracture from a maxillofacial surgeon's perspective--review of the literature and proposal of a management algorithm. Int J Oral Maxillofac Surg. 2016;45:297-303.
22. Ghabanchi J, Haghnegahdar A, Khojastehpour L, Ebrahimi A. Frequency of tonsilloliths in panoramic views of a selected population in southern iran. J Dent (Shiraz). 2015;16:75-80.
23. Icoz D, Akgunlu F. Prevalence of detected soft tissue calcifications on digital panoramic radiographs. SRM Journal of Research in Dental Sciences. 2019;10:21-5.

24. Takahashi A, Sugawara C, Kudoh T et al. Prevalence and imaging characteristics of palatine tonsilloliths evaluated on 2244 pairs of panoramic radiographs and CT images. Clin Oral Investig. 2017;21:85-91.
25. Acikgoz A, Akkemik O. Prevalence and radiographic features of head and neck soft tissue calcifications on digital panoramic radiographs: a retrospective study. Cureus. 2023;15:e46025.
26. Maia PRL, Tomaz AFG, Maia EFT, et al. Prevalence of soft tissue calcifications in panoramic radiographs of the maxillofacial region of older adults. Gerodontology. 2022;39:266-72.
27. Lopes IA, Tucunduva RM, Handem RH, Capelozza AL. Study of the frequency and location of incidental findings of the maxillofacial region in different fields of view in CBCT scans. Dentomaxillofac Radiol. 2017;46:20160215.
28. Missias EM, Nascimento E, Pontual M et al. Prevalence of soft tissue calcifications in the maxillofacial region detected by cone beam CT. Oral Dis. 2018;24:628-37.
29. Pette GA, Norkin FJ, Ganeles J et al. Incidental findings from a retrospective study of 318 cone beam computed tomography consultation reports. Int J Oral Maxillofac Implants. 2012;27:595-603.
30. Diniz V, Corrêa ECDCB, Gonçalves BC et al. Prevalence of soft tissue calcifications in cone beam computed tomography images in the region of head and neck. Brazilian Dental Science. 2020;23:6-p.
31. Ozdede M, Akay G, Karadag O, Peker I. Comparison of panoramic radiography and cone-beam computed tomography for the detection of tonsilloliths. Med Princ Pract. 2020;29:279-84.
32. Oda M, Kito S, Tanaka T et al. Prevalence and imaging characteristics of detectable tonsilloliths on 482 pairs of consecutive CT and panoramic radiographs. BMC Oral Health. 2013;13:54.
33. More CB, Asrani MK. Evaluation of the styloid process on digital panoramic radiographs. Indian J Radiol Imaging. 2010;20:261-5.
34. Zokaris N, Siska I, Natsis K et al. Investigation of the styloid process length in a Greek population. Folia Morphol (Warsz). 2019;78:378-88.
35. Guimarães AC, Pozza DH, Guimarães AS. Prevalence of morphological and structural changes in the stylohyoid chain. J Clin Exp Dent. 2020;12:e1027-32.
36. Togan B, Gander T, Lanzer M, et al. Incidence and frequency of nondental incidental findings on cone-beam computed tomography. J Craniomaxillofac Surg. 2016;44:1373-80.
37. Okabe S, Morimoto Y, Ansai T, et al. Clinical significance and variation of the advanced calcified stylohyoid complex detected by panoramic radiographs among 80-year-old subjects. Dentomaxillofac Radiol. 2006;35:191-9.
38. Andrei F, Motoc AG, Didilescu AC, Rusu MC. A 3D cone beam computed tomography study of the styloid process of the temporal bone. Folia Morphol (Warsz). 2013;72:29-35.
39. Ilgüy D, Ilgüy M, Fişekçioğlu E, Dölekoğlu S. Assessment of the stylohyoid complex with cone beam computed tomography. Iran J Radiol. 2012;10:21-6.
40. Alpoz E, Akar GC, Celik S, et al. Prevalence and pattern of stylohyoid chain complex patterns detected by panoramic radiographs among Turkish population. Surg Radiol Anat. 2014;36:39-46.