

RESEARCH ARTICLE

Lingual tonsillolith: prevalence and imaging characteristics evaluated on 2244 pairs of panoramic radiographs and CT images

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Objectives: Lingual tonsilloliths are not as well-known to radiologists than palatine tonsilloliths, although they might be common in clinical practice. The aim of this investigation was to clarify the prevalence and imaging characteristics of lingual tonsilloliths using panoramic radiographs and CT images.

Methods: This study included 2244 patients without pathology at the base of tongue who had undergone panoramic radiography and CT of the maxillofacial region. The size, number and position of lingual tonsilloliths relative to the mandible and tongue were evaluated.

Results: Lingual tonsilloliths were observed in 33 (1.5%) and 108 (4.8%) of all patients on panoramic radiographs and CT images, respectively. The prevalence was higher in patients aged ≥ 40 years than in those aged < 40 years (χ^2 , $p < 0.01$). They appeared as small, round- or rod-shaped calcified bodies, and they always located closely anterior (1–17 mm) to the anterior border of oropharyngeal airway on panoramic radiographs. Lingual tonsilloliths were superimposed over the surrounding soft tissue inferior to the body of the mandible, posteroinferior to the angle of the mandible and posterior to the mandible in 16 (48.5%), 15 (45.5%) and 1 (3.0%) individual, respectively. A significant correlation was observed between the detectability on panoramic radiographs and size (Spearman's $r = 0.961$, $p < 0.01$) of tonsilloliths, as revealed by CT images.

Conclusion: Lingual tonsilloliths commonly appear on CT. They also appear on panoramic radiography and may superimpose the surrounding soft tissue of the mandible. Although lingual tonsilloliths may resemble other pathological calcifications including submandibular sialoliths and lingual osseous cholelithoma, they can be differentiated by carefully observing panoramic radiographs. When clinicians detect calcified bodies near the base of tongue, lingual tonsilloliths should be included in the differential diagnoses.

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Keywords: panoramic radiography; X ray computed tomography; tonsil; tongue; calculi

Introduction

Tonsilloliths are concretions within enlarged tonsillar crypts. Most tonsilloliths are asymptomatic and no treatment is required.¹ However, recent studies suggest that tonsilloliths are clinically related to halitosis, throat

irritation, dysphagia and foreign body sensation upon swallowing.^{2,3} Tonsilloliths might also cause glossopharyngeal neuralgia or orofacial pain,⁴ upper airway obstruction,⁵ and sleep disordered breathing.⁶ Furthermore, large tonsilloliths may cause life-threatening conditions including dyspnea, esophageal perforation and mediastinitis.⁷

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Waldeyer's tonsillar ring is composed of palatine, lingual, pharyngeal and Eustachian tube tonsils. Previous investigations revealed palatine tonsilloliths are commonly detected on CT and/or panoramic radiography (PR) at an incidence of 16–46.1% on CT and 7.3–13.4% on PR.^{8–13} On panoramic radiographs, palatine tonsilloliths may appear as multiple, poorly defined small radiopaque masses. Previous groups also showed the clinical importance of differentiating palatine tonsilloliths from pathological calcifications including submandibular sialoliths, phleboliths and calcification of the lymph nodes. Similar to palatine tonsilloliths, lingual tonsilloliths may appear incidentally based on empirical knowledge. However, only two case reports were found concerning lingual tonsilloliths;^{14,15} thus, the prevalence and characteristics of lingual tonsilloliths on clinical imaging are unknown.

Therefore, in this study, we aimed to clarify the prevalence and imaging characteristics of lingual tonsilloliths on PR and CT.

Methods and materials

This study was designed as a retrospective review and approved by the Ethics Committee of Tokushima University Hospital, Japan (No. 1580) for analysis of medical records and imaging data. Medical records and images were collected from 2244 consecutive patients with maxillofacial diseases and without tonsillar pathology who had both PR and CT taken between 2004 and 2012.

Panoramic radiographs were obtained using Veraviewepocs (Morita, Osaka, Japan) with standard locus and image processing. CT images were obtained using Aquilion (Toshiba, Tokyo, Japan) with 16-row multi-detectors. The scan parameters were as follows: tube voltage was fixed at 140 kVp, both scan thickness and reconstruction thickness were 1 mm and the scanning plane was parallel to the occlusal plane and/or inferior border of the mandible. Images were obtained using both standard soft tissue and bone algorithms. All images were observed on display monitors used for medical purposes.

Prior to the cumulative study, interobserver agreement was calculated by κ statistics. We randomly selected 200 panoramic radiographs and CT images of 200 patients. Two radiologists (AT and CS) independently evaluated the presence of lingual tonsilloliths on those images. The interobserver κ was 0.86 (almost perfect) for panoramic radiographs and 1.00 (perfect) for CT images, respectively. This result tells that the interobserver difference might be negligible in detecting lingual tonsilloliths. Therefore, the complete evaluation for 2244 patients was performed by a single radiologist (AT). The presence of lingual tonsilloliths on panoramic radiographs was evaluated as follows. The locations of tonsilloliths were classified into two categories and three regions (Figure 1). Category 1

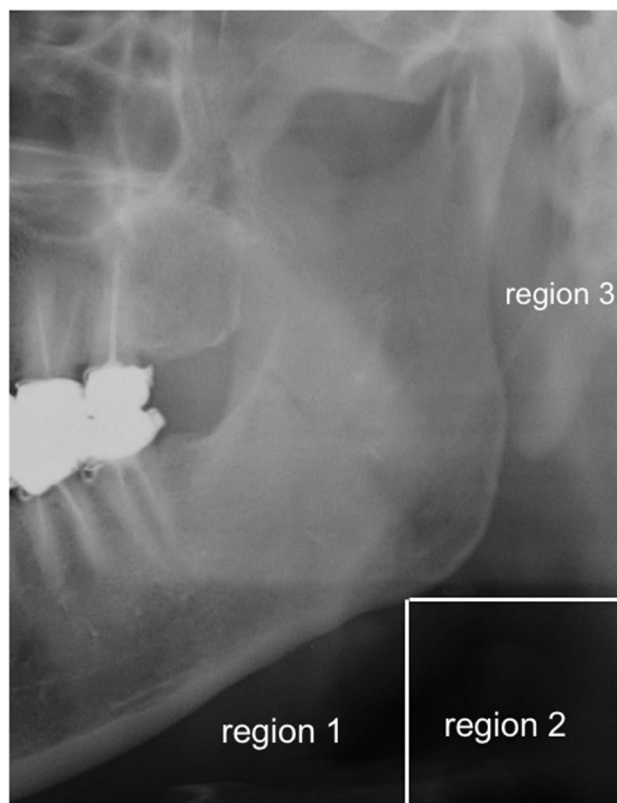


Figure 1 Locations of lingual tonsilloliths that were superimposed over the soft tissue surrounding the mandible on panoramic radiographs. Region 1: inferior to the body of the mandible; Region 2: posteroinferior to the angle of the mandible; Region 3: posterior to the ramus of the mandible.

was defined as calcifications that were superimposed over the mandible. Category 2 was defined as calcifications that were superimposed over the soft tissue surrounding the mandible. Category 2 was divided into three regions as follows: inferior to the body of the mandible (region 1), posteroinferior to the angle of the mandible (region 2) and posterior to the ramus of the mandible (region 3). Then, the size of lingual tonsilloliths on panoramic radiographs were evaluated. To evaluate the location of lingual tonsilloliths relative to the tongue, the soft tissue shadow that coincides with the anterior border of the oropharyngeal airway on panoramic radiograph was defined as the posterior edge of the base of tongue. The distance between the center of lingual tonsilloliths and the posterior edge of the base of tongue was measured (Figure 2). We selected the largest tonsil as the representative one in patients with multiple tonsilloliths. In the measurement on panoramic radiographs, we calculated based on the pixel size, which was $96 \times 96 \mu\text{m}$ on DICOM format. As the lingual tonsilloliths were located apart from the focal trough, we could not apply the magnification factor of this apparatus, which was 1.3 on the focal trough. Therefore, we did not correct the dimensions on panoramic radiographs.

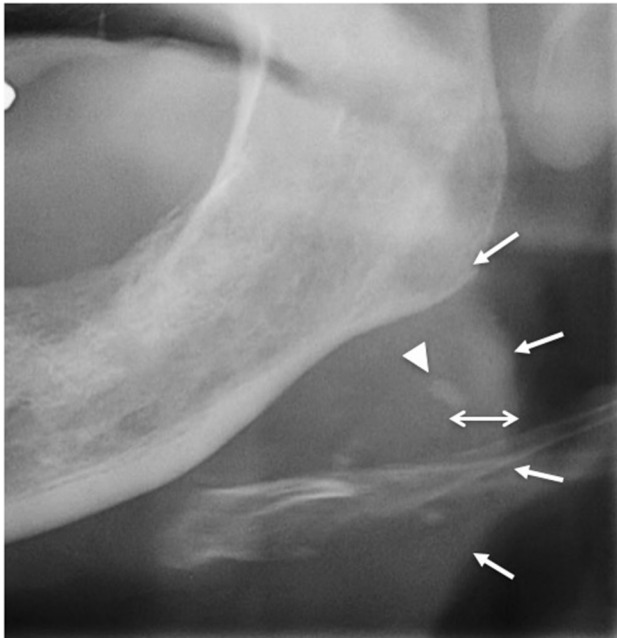


Figure 2 Posterior edge of the base of tongue (soft tissue shadow that coincides with the anterior border of oropharyngeal airway; arrows), lingual tonsillolith (arrowhead) and distance from the base of tongue to center of lingual tonsillolith (double-headed arrow) on panoramic radiographs.

Using CT images, the number and diameter of lingual tonsilloliths were also evaluated. Panoramic radiographs and CT images were observed separately at least 2 weeks apart, and the findings of PR not obtained during CT observation. After CT evaluation, panoramic radiographs were then re-evaluated to determine whether the calcifications matched those on CT images. If the calcifications on PR were proven to be other than lingual tonsilloliths on CT, then they were excluded from the study. 42 enostoses (dense bone islands), 36 submandibular sialoliths, 19 remarkable atherosclerotic calcifications, 4 calcified lymph nodes, 3 remnants of contrast media within parotid glands and 1 osteoma cutis were excluded as pathological conditions. 11 calcified stylohyoid ligaments and three partial calcifications of thyroid cartilages were also excluded as physiological conditions.

Commercially available software (SPSS v. 23.0.0; IBM Corp., Armonk, NY) was used for data evaluation. Categorical values were compared using the chi-square test, and relationships between categorical

Table 1 Sex differences in the detection rate of lingual tonsilloliths on PR and CT

Sex	Total	PR		CT		Detection rate of PR
		Presence (%)	Presence (%)	Presence (%)	Presence (%)	
Male	1060	21 (1.9)	55 (5.2)	38.2%		
Female	1184	12 (1.0)	53 (4.5)	22.6%		
Total	2244	33 (1.5)	108 (4.8)	30.6%		

PR, panoramic radiography.

Table 2 Prevalence of lingual tonsilloliths by age group

Age (Years)	Total	PR		CT	
		Presence (%)	Presence (%)	Presence (%)	Presence (%)
<9	25	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
10–19	182	0 (0.0)	1 (0.5)	1 (0.5)	1 (0.5)
20–29	210	1 (0.5)	1 (0.5)	1 (0.5)	1 (0.5)
30–39	229	0 (0.0)	1 (0.4) ^a	1 (0.4) ^a	1 (0.4) ^a
40–49	257	2 (0.8)	14 (5.4)	14 (5.4)	14 (5.4)
50–59	433	6 (1.4)	26 (6.0)	26 (6.0)	26 (6.0)
60–69	446	15 (3.4)	37 (8.3)	37 (8.3)	37 (8.3)
70–79	322	6 (1.9)	22 (6.8)	22 (6.8)	22 (6.8)
80–89	126	3 (2.4)	6 (4.8)	6 (4.8)	6 (4.8)
>90	14	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total	2244	33 (1.5)	108 (4.8)	108 (4.8)	108 (4.8)

PR, panoramic radiography.

^aThe prevalence of lingual tonsilloliths in patients aged 40–49 years was significantly higher than in those aged 30–39 years on CT ($p < 0.01$). The prevalence was also higher in patients aged ≥ 40 years than in those aged < 40 years ($p < 0.01$).

values were assessed using Spearman’s rank correlation coefficient. The results were considered significant at $p < 0.05$.

Results

Lingual tonsilloliths were found in 108 (4.8%) of 2244 individuals on CT images (Table 1). These patients included 55 males and 53 females. On panoramic radiographs, lingual tonsilloliths were found in 33 (1.5%) of 2244 individuals. These patients included 21 males and 12 females; no sex differences were observed. Panoramic radiographs showed 30.6% of lingual tonsilloliths detected via CT images. The prevalence was higher in older patients than younger patients on both panoramic radiographs and CT images (Table 2). The prevalence of lingual tonsilloliths in patients aged 40–49 years was significantly higher than those aged 30–39 years on CT ($p < 0.01$). The prevalence was also higher in patients aged ≥ 40 years than in those aged < 40 years ($p < 0.01$).

On panoramic radiographs, lingual tonsilloliths were predominantly superimposed over the soft tissue surrounding the mandible (category 2) (Table 3). They were located in region 1 (inferior to the body of the

Table 3 Location and prevalence of lingual tonsilloliths on PR

Location	Number of patients (%)	
Category 1: ramus of mandible	1	(3.0)
Category 2: soft tissue		
Region 1: inferior to the body of the mandible	16	(48.5)
Region 2: posteroinferior to the angle of the mandible	15	(45.5)
Region 3: posterior to the ramus of the mandible	1	(3.0)

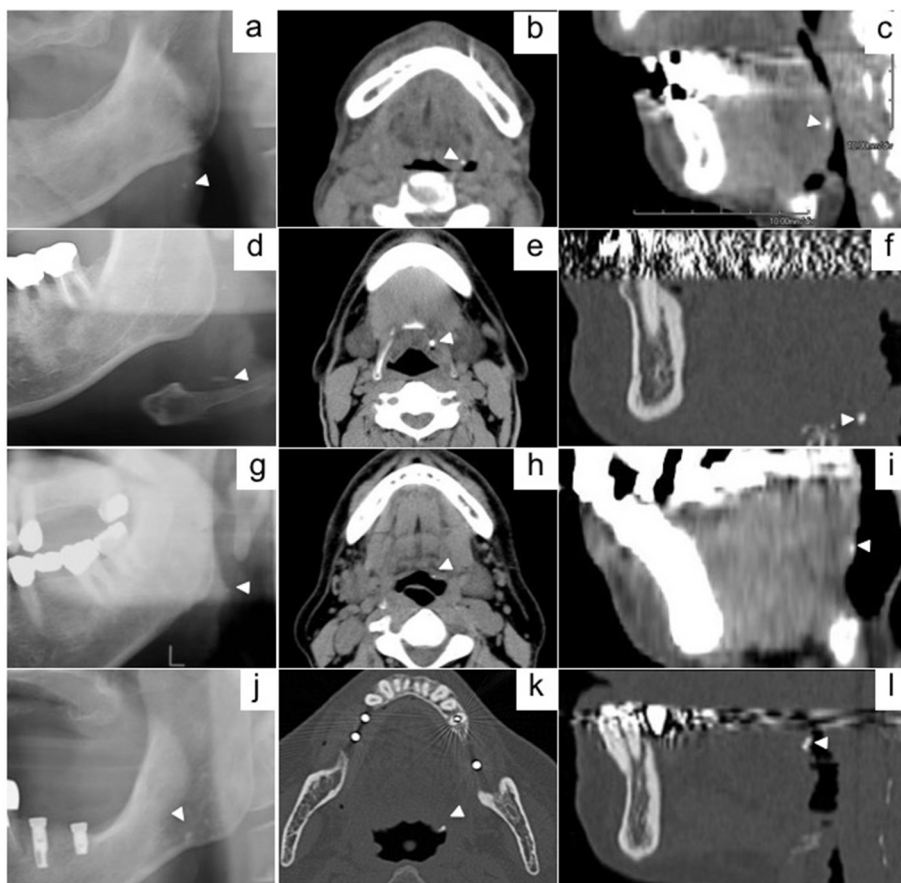


Figure 3 Panoramic radiographs (a, d, g, j), axial CT images (b, e, h, k) and sagittal reconstructed CT images (c, f, i, l) of lingual tonsilloliths. (a-c) Representative images of a lingual tonsillolith (arrowhead) inferior to the body of the mandible (region 1). (d-f) Representative images of a lingual tonsillolith (arrowhead) posteroinferior to the angle of the mandible (region 2). (g-i) Representative images of a lingual tonsillolith (arrowhead) posterior to the ramus of the mandible (region 3). (j-l) Representative images of a lingual tonsillolith (arrowhead) near the base of the mandible (category 1).

mandible) in 16 individuals (48.5%) (representative images, [Figure 3a–c](#)), region 2 (posteroinferior to the angle of the mandible) in 15 individuals (45.5%) (representative images, [Figure 3d–f](#)) and region 3 (posterior to the ramus of the mandible) in 1 individual (3.0%) (representative images, [Figure 3g–i](#)). Lingual tonsilloliths were also superimposed over the mandible (category 1) in one individual (3.0%) (representative images, [Figure 3j–l](#)).

The sizes of lingual tonsilloliths ranged from 1 to 4 mm on CT. The detection rate of PR increased with increasing size (Spearman's $r = 0.961$, $p < 0.01$) ([Table 4](#)). On CT, 1–8 tonsilloliths could be observed in a single patient. However, the detection rate of PR was not related to the number of tonsilloliths (Spearman's $r = 0.259$, $p > 0.05$) ([Table 5](#)).

The size of lingual tonsilloliths on panoramic radiographs ranged from 1 to 6 mm. In detail, 21 tonsilloliths (63.6%) were < 3 mm and 12 tonsilloliths (36.4%) were ≥ 3 mm ([Table 6](#)). Tonsilloliths < 3 mm were round-shaped, whereas tonsilloliths > 3 mm were generally rod-shaped. The distance between lingual tonsilloliths and the posterior edge of the base of

tongue on panoramic radiographs ranged from 1 to 17 mm ([Table 7](#)). This distance was < 6 mm in 24 tonsilloliths (72.7%), 6–10 mm in six tonsilloliths (18.2%) and ≥ 10 mm in three tonsilloliths (9.1%). All tonsilloliths were located anterior to the base of tongue ([Figure 4](#)). Representative images of a lingual tonsillolith located mostly apart from the base of tongue are shown in [Figure 4a–c](#). The tonsillolith was located 17 mm anteriorly from the edge of the base of tongue on panoramic radiographs. Representative images of a

Table 4 Size of lingual tonsilloliths on CT and detectability of PR

Size on CT (mm)	Number of patients detected by PR	Number of patients detected by CT	Detection rate of PR compared with CT (%)
1	10	49	20.4
2	18	46	39.1
3	4	12	33.3
4	1	1	100.0
Total	33	108	30.6

PR, panoramic radiography.

A significant correlation was observed between the detectability on panoramic radiographs and size of tonsilloliths (Spearman's $r = 0.961$, $p < 0.01$).

Table 5 Number of lingual tonsilloliths on CT and detectability of PR

Number on CT	Number of patients detected by PR	Number of patients detected by CT	Detection rate of PR compared with CT (%)
1	20	82	24.4
2	10	17	58.8
3	2	4	50.0
4	0	2	0.0
5	0	2	0.0
6	0	0	N/A
7	0	0	N/A
8	1	1	100.0
Total	33	108	30.6

N/A, not applicable; PR, panoramic radiography. No significant correlation was observed between the detection rate on panoramic radiographs and the number of tonsilloliths (Spearman's $r = 0.259$, $p > 0.05$).

lingual tonsillolith located near the surface of the base of tongue are shown in [Figure 4d–f](#).

Discussion

In the present study, PR detected lingual tonsilloliths in 1.5% of the study population, with a detection rate of 30.6% compared with CT findings. The size of lingual tonsilloliths significantly influenced detectability. Most lingual tonsilloliths were superimposed over the surrounding soft tissue of the mandible and located near the soft tissue shadow of the base of tongue on panoramic radiographs. To our knowledge, this is the first study to demonstrate the prevalence and imaging characteristics of lingual tonsilloliths both by PR and CT.

Tonsilloliths can be caused by chronic tonsillitis with infectious agents such as fungi, bacteria and *Actinomyces* combining with pus cells to serve as an ideal location for stone formation.¹⁶ Among them, palatine tonsilloliths are commonly encountered in clinical practice. Previous reports showed that palatine tonsilloliths were one of the most common findings among pathological and physiological calcifications in the head and neck region, with rates ranging from 16 to 46.1%.^{8–12} However, there are few reports regarding lingual tonsilloliths. To our knowledge,

Table 6 Size of lingual tonsilloliths on PR

Size on PR (mm)	Number of patients detected by PR (%)
1	8 (24.2)
2	13 (39.4)
3	6 (18.2)
4	2 (6.1)
5	3 (9.1)
6	1 (3.0)
Total	33 (100.0)

PR, panoramic radiography.

Table 7 Distance between lingual tonsilloliths and the posterior edge of the base of tongue on PR

Distance on PR (mm)	Number of patients detected by PR (%)
1	4 (12.1)
2	9 (27.3)
3	3 (9.1)
4	3 (9.1)
5	5 (15.2)
6–10	6 (18.2)
> 10	3 (9.1)
Total	33 (100.0)

PR, panoramic radiography.

no reports are available in the English literature, and only two case reports have been published in the Japanese literature.^{14,15} In these reports, the main clinical symptom was discomfort or anterior neck pain. A foreign body such as fishbone was initially suspected by otolaryngologists in both cases because the symptoms appeared just after consuming food, and small calcified bodies were observed on CT. Furthermore, the prevalence of lingual tonsilloliths has not yet been reported. In this study, PR detected lingual tonsilloliths in 1.5% of the study population. Lingual tonsilloliths were confirmed to be more commonly observed when compared to diseases that require medical treatment including sialoliths or phleboliths. Therefore, clinicians should be aware of the high prevalence of lingual tonsilloliths and its imaging characteristics during PR observation. When abnormal calcifications are detected incidentally by PR, clinicians should diagnose the condition correctly as early as possible to minimize unnecessary diagnostic imaging.

In the present study, the lingual tonsillolith detection rate of PR was 30.6% via CT. In our previous study, the palatine tonsillolith detection rate in the same cohort was similar (32.8%).¹³ Compared with palatine tonsilloliths, lingual tonsilloliths are generally smaller in size, fewer in number and located medially and away from the focal trough of the panoramic apparatus. Therefore, we hypothesized that the detection rate for lingual tonsilloliths by PR would be lower than that of palatine tonsilloliths. A potential explanation for the discrepancy might be as follows: because palatine tonsilloliths are frequently detected superimposed over the mandible on panoramic radiographs,¹³ small or faint tonsilloliths may be obscured. Additionally, the lingual tonsillolith detection rate was significantly higher in participants aged > 40 years in the present study. This same tendency was observed in our previous study concerning palatine tonsilloliths.¹³ Although the reason is unclear, it is possible that chronic oropharyngeal inflammation persists in

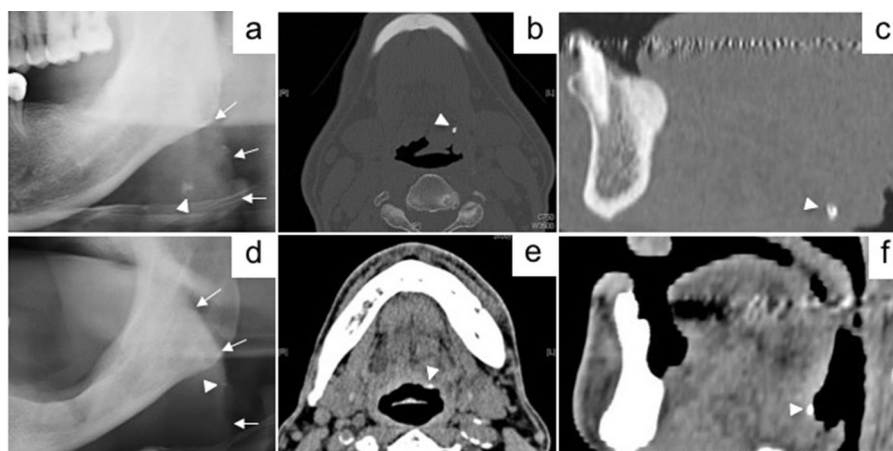


Figure 4 Location of lingual tonsilloliths relative to the soft tissue shadow of the base of tongue. Panoramic radiographs (a, d), axial CT images (b, e) and sagittal reconstructed CT images (c, f) of lingual tonsilloliths. Lingual tonsillolith (arrowheads) and soft tissue shadow of the base of tongue (arrows). (a–c) Representative images of a lingual tonsillolith located mostly apart from the base of tongue. The tonsillolith was located 17 mm anteriorly from the edge of the base of tongue on panoramic radiographs. (d–f) Representative images of a lingual tonsillolith located near the surface of the base of tongue.

older patients because of higher smoking rates and/or poor oral hygiene.^{17,18}

On panoramic radiographs, lingual tonsilloliths were most frequently superimposed over the soft tissue surrounding the mandible (category 2), primarily located inferior to the mandible (48.5% in region 1) and posteroinferior to the mandible (45.5% in region 2). As these are also frequent sites for submandibular sialoliths, clinicians must be aware of the imaging characteristics of lingual tonsilloliths on panoramic radiographs to differentiate them from sialoliths. In particular, lingual tonsilloliths were located near the posterior edge of the base of tongue on panoramic radiographs, at a distance 1–17 mm anteriorly. On panoramic radiographs, the position of the posterior edge of the base of tongue relative to the mandible may change if the positioning or swallowing phase differs at imaging. Hence, the location of calcifications relative to the base of tongue might be more important in the differential diagnosis. Furthermore, lingual tonsilloliths ranged from 1 to 4 mm, which is generally smaller than sialoliths. Large lingual tonsilloliths were generally rod-shaped on panoramic radiographs, although most were round-shaped on CT images. We speculate that some of the large, rod-shaped lingual tonsilloliths may be horizontally distorted because they are at a distance from the focal trough of PR. Therefore, the imaging characteristics of lingual tonsilloliths are small, round- or rod-shaped calcified bodies located near the base of tongue on panoramic radiographs. These findings might provide helpful clues in the differential diagnosis of lingual tonsilloliths.

In the differential diagnosis of the lingual tonsilloliths, lingual osseous cholelithoma, which was also

known as lingual osteoma, should be considered. This lesion has been reported in less than 100 cases. Compared to the lingual tonsilloliths, lingual osseous cholelithoma had a female predilection, and the mean age was 31.4 years. Most of these were located in the dorsum of the tongue and the size ranged from 0.5 to 5.0 cm.^{19,20} Other conditions, such as calcification of the stylohyoid ligament and thyroid or triticeal cartilage, should also be considered in the differential diagnosis. Moreover, pathological calcifications such as calcification of the lymph nodes, atherosclerotic calcification of the carotid or facial arteries, phleboliths, loose bodies from the vertebrae, cysticercosis, calcified acne, osteoma cutis (miliary osteoma of the skin), myositis ossificans and foreign bodies should be considered.^{1,8,16,21–24} The imaging characteristics of lingual tonsilloliths presented in this study will aid in the differentiation of these calcified conditions.

Conclusion

Lingual tonsilloliths commonly appeared and were detected with frequencies of 4.8% on CT images and 1.5% on panoramic radiographs. The detection rate of PR was 30.6% via CT. On panoramic radiographs, most lingual tonsilloliths were superimposed over the soft tissue surrounding the mandible. They appeared as small, round- or rod-shaped calcified bodies anterior to the soft tissue shadow of the base of tongue on panoramic radiographs. Clinicians should be aware that lingual tonsilloliths are not uncommon, and lingual tonsilloliths should be included in the differential diagnosis of calcified bodies over the soft tissue surrounding the mandible.

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