

Bilateral and pseudobilateral tonsilloliths: Three dimensional imaging with cone-beam computed tomography

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ABSTRACT

Purpose: Tonsilloliths are calcifications found in the crypts of the palatal tonsils and can be detected on routine panoramic examinations. This study was performed to highlight the benefits of cone-beam computed tomography (CBCT) in the diagnosis of tonsilloliths appearing bilaterally on panoramic radiographs.

Materials and Methods: The sample group consisted of 7 patients who had bilateral radiopaque lesions at the area of the ascending ramus on panoramic radiographs. CBCT images for every patient were obtained from both sides of the jaw to determine the exact locations of the lesions and to rule out other calcifications. The calcifications were evaluated on the CBCT images using Ez3D2009 software. Additionally, the obtained images in DICOM format were transferred to ITK SNAP 2.4.0 pc software for semiautomatic segmentation. Segmentation was performed using contrast differences between the soft tissues and calcifications on grayscale images, and the volume in mm³ of the segmented three dimensional models were obtained.

Results: CBCT scans revealed that what appeared on panoramic radiographs as bilateral images were in fact unilateral lesions in 2 cases. The total volume of the calcifications ranged from 7.92 to 302.5 mm³. The patients with bilaterally multiple and large calcifications were found to be symptomatic.

Conclusion: The cases provided the evidence that tonsilloliths should be considered in the differential diagnosis of radiopaque masses involving the mandibular ramus, and they highlight the need for a CBCT scan to differentiate pseudo- or ghost images from true bilateral pathologies. (*Imaging Sci Dent 2013; 43: 163-9*)

KEY WORDS: Tonsillolith; Panoramic Radiography; Cone-Beam Computed Tomography

Introduction

Tonsillar calcifications, or tonsilloliths, are rare formations that have been found in the crypts of the palatal tonsils. These calculi are composed of calcium salts such as hydroxyapatite or calcium carbonate apatite, oxalates, and other magnesium salts, and they are thought to be a result of chronic inflammation of the tonsils.¹ Tonsilloliths develop within a mass of desquamated epithelium, serum, food

debris, and bacterial colonies.² The majority are located in tonsillar tissue (69.7%), but they may also occur in the tonsillar fossa (21.2%) and palatine tonsil (9%). Tonsilloliths range in size from a few millimeters to several centimeters.³ A review study by Ram et al reported that 26 cases of tonsilloliths appeared in the literature from 1920-2003, with the mean age of occurrence 46.2 years (age range: 16-77 years), a 2 : 1 male : female ratio and a preponderance located on the right tonsil; the heaviest and lightest tonsilloliths were reported to weigh 42 g and 300 mg, respectively (mean weight: 14.7 g).⁴

While small concretions may be asymptomatic, larger tonsilloliths may present with pain and a foreign-body sensation in the throat, swelling in the tonsillar fossa, dys-

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phagia, otalgia, peritonsillar abscess, and halitosis.¹ Tonsilloliths may be incidentally detected on panoramic radiographs,³ where they appear as radiopaque shadows over the middle portion of the ascending mandibular ramus.⁵ Such small, ill-defined radiopacities can be difficult to differentiate: depending on the relationship with the surrounding structures in the mandibular molar-ramus region, they may be interpreted as foreign bodies, odontomas, osteomas, sialoliths, phleboliths, cysticercosis, calcified lymph nodes, carotid artery arteriosclerosis, stylohyoid ligament mineralization, or dystrophic calcifications in acne scars. Moreover, the superimposition of hard- and soft-tissue structures is common in this anatomic region, and the resulting 'ghost' images can mislead clinicians into interpreting a unilateral lesion as bilateral lesions.⁶ This difficulty may be overcome with the use of computed tomography (CT).

CT is reported to be the most convenient and accurate imaging modality currently available. Through multiple slices and alternative views, surgeons can relatively easily and accurately determine the size and location of a tonsillolith within the surrounding inflammation, although the appearance is still not pathognomonic.⁷ In comparison to CT, cone-beam computed tomography (CBCT) offers the advantages of significantly lower radiation exposure, reasonably short scanning times, and a more compact design with sufficient accuracy.⁸ The use of the three-dimensional (3D) information provided by CBCT as a complement to the two-dimensional (2D) overviews provided by conventional radiographic techniques has been reported to greatly facilitate diagnosis and pre-surgery planning for a variety of dentomaxillofacial applications.⁹

This study was performed to highlight the benefits of CBCT in the diagnosis of tonsilloliths appearing bilaterally on panoramic radiographs.

Materials and Methods

The study was conducted with 7 subjects (3 female, 4 male) aged 31-73 selected from 3,753 patients who underwent clinical and panoramic radiographic examinations in the Department of Oral and Maxillofacial Radiology between January and November of 2012. Patients with bilateral radiopaque lesions at the area of the ascending ramus on panoramic radiographs were selected by two oral radiologists and one oral surgeon. Exclusion criteria for the study were 1) history of tuberculosis or any other granulomatous diseases, 2) Gardner's syndrome, familial polyposis of the colon and other diseases that involve a metabolic bone disturbance, 3) symptoms of an obstructive parotitis,

4) parotid swellings with or without pain, 5) any association with hemangioma, and 6) radiopacities with a surrounding radiolucent rim. All of the patients agreed to participate in the study and signed an informed consent form.

For every patient, CBCT images were obtained from both sides of the jaw in order to determine the exact locations of the lesions and to rule out other calcifications including sialoliths, phleboliths, and lymph node calcifications as follows. Sialoliths are usually associated with pain and swelling of the involved salivary gland and calcifications in the parotid gland are located on the exterior of the mandible on coronal and axial tomographic images. Phleboliths are usually multiple and have a more random, clustered distribution. They are usually associated with hemangiomas. Furthermore, the opacity of the phlebolith tends to be lamellated, while tonsilloliths are usually evenly opaque. Lymph node calcifications are usually located in the submandibular region and associated with tuberculosis or granulomatous diseases.^{10,11}

Panoramic radiographs were taken using PaxUni 3D (Vatech, Seoul, Korea) set at 60-80 kVp, 8-10 mA, and 9.7 seconds and OP 200D (Instrumentarium Dental, Tuusula, Finland) digital orthopantomograph devices set at 57-85 kVp, 2-16 mA, and 8 seconds. In all 7 cases, PaxUni 3D was also used to capture CBCT images at the following settings: 50-90 kVp, 4-10 mA, and seconds exposure time, and a 50 × 50 mm field of view (FOV) size. Coronal, axial, and 3D images were examined by two oral radiologists using Ez3D2009 (Vatech, Seoul, Korea) software. In order to measure calcification volumes, the images in DICOM format were transferred to ITK-SNAP 2.4.0 (Kitware, New York, USA) PC software that is used for medical image processing. Here, ITK-SNAP is an interactive image segmentation software developed to implement an active contour segmentation of structures, allowing regional segmentation by employing user-initialized deformable implicit surfaces that evolve to the most appropriate border between neighboring structures. Segmentation is the process by which appropriate reference points (voxels) are assigned to be part of a specific structure.¹²

The coronal, sagittal, and axial images were used to define the calcifications in ITK-SNAP software and semi-automatic segmentation was performed by one oral radiologist with selection of reference points on calcifications with a computer mouse.¹²⁻¹⁴ The software automatically segmented the calcifications starting from the reference points using the contrast differences between the soft tissue and calcifications on the greyscale images. Subsequent to

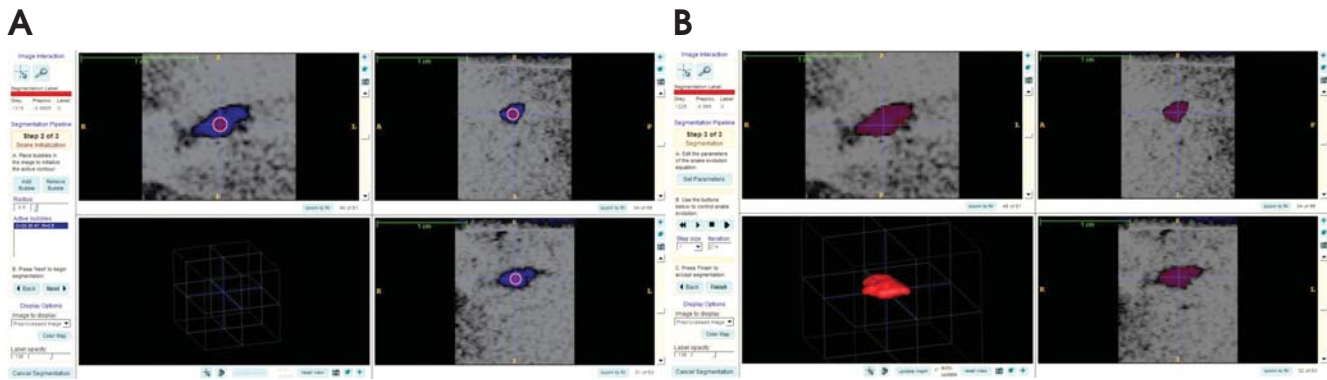


Fig. 1. A. Selection of reference points in the area of interest is performed. B. ITK-SNAP software allows semiautomatic segmentation of calcifications.

the segmentation, a 3D-graphical model of the volumetric object was generated by the software and the volume in mm^3 of the segmented 3D model was obtained (Fig. 1).

The patients with severe symptoms including dysphagia and recurrent tonsil infection were referred to the Faculty of Medicine's Department of Otorhinolaryngology for consultation and one of the patients also underwent an MRI to confirm the diagnosis before surgery. The remaining patients underwent follow-up care.

Results

There were 4 males and 3 females who had tonsilloliths in this study. The age range of the subjects was 31-73 years (mean age: 51 years). The examination of CBCT images on coronal plane, axial, and 3D images using Ez3D2009 software showed the lesions to be located medially to each mandibular ramus and in the palatine tonsils. Irregularly shaped dense calcifications were detected in the palatal tonsils of all of the patients. In the ITK-SNAP software, bilateral calcifications were identified in 5 cases (bilaterally multiple in 3, unilaterally multiple in 2 cases) (Fig. 2) and a unilateral solitary calcification was identified in 2 cases (Table 1). CBCT images revealed that what appeared on panoramic radiographs as bilateral images were in fact unilateral lesions and their ghost images on the opposite side in these 2 cases (Fig. 3).

The total volume of calcifications ranged from 7.92 mm^3 to 302.5 mm^3 . Four of the patients had symptoms including dysphagia, halitosis and tonsil infection, but the remaining 3 patients were asymptomatic. The patients with bilaterally multiple and larger calcifications showed more severe symptoms (Table 1). In one of the patients, magnetic resonance image (MRI) results also confirmed the diagnosis of tonsilloliths by CBCT (Fig. 4).

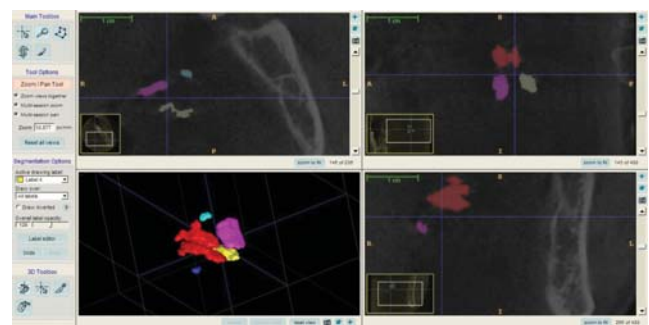


Fig. 2. The CBCT images show a patient with multiple calcifications. Every calcification can be segmented with a different color with ITK-SNAP software.

Discussion

Although the exact etiology and pathogenesis of tonsilloliths is unknown, most authors have believed these concretions to be the result of unresolved tonsillitis. Others, however, have suggested that tonsilloliths developed as a result of stasis of the saliva in the efferent ducts of the accessory salivary glands secondary to mechanical obstruction arising from post-tonsillectomy scars or chronic inflammation.³ Tonsillar concretions may produce symptoms that include non-specific chronic halitosis, irritable cough, dysphagia, and otalgia as well as a foreign-body-like sensation and foul taste.¹⁵ Patients with tonsilloliths may also be asymptomatic, with their lesions discovered incidentally on panoramic or other skull radiographs.¹⁶

Calcifications in palatal tonsils were observed in the 7 cases in our study. Past histories did not suggest any particular etiology. The absence of clinical signs and symptoms might have originated from the small size of the calcifications, which remained undiagnosed until their inci-

Table 1. Calcification characteristics of cases

| Patient | Age/Sex | Location | Calcification type at right side (number) | Calcification type at left side (number) | Total volume: right side (mm ³) | Total volume: left side (mm ³) | Signs/Symptoms |
|---------|---------|---------------------------|---|--|---|--|---|
| 1 | 61/F | Bilateral | Multiple (11) | Multiple (5) | 97.15 | 302.5 | Recurrent tonsillitis, dysphagia, halitosis |
| 2 | 63/M | Bilateral | Multiple (4) | Multiple (6) | 22.19 | 87.47 | Recurrent tonsillitis, halitosis |
| 3 | 33/F | Bilateral | Multiple (3) | Multiple (3) | 89.81 | 85.64 | Recurrent tonsillitis, dysphagia, halitosis |
| 4 | 31/M | Bilateral | Multiple (3) | Solitary | 15.25 | 11.19 | Asymptomatic |
| 5 | 62/F | Bilateral | Solitary | Multiple (3) | 7.92 | 20.55 | Asymptomatic |
| 6 | 73/M | Unilateral (Right tonsil) | Solitary | – | 16.82 | – | Asymptomatic |
| 7 | 34/M | Unilateral (Left tonsil) | – | Solitary | – | 11.80 | Halitosis |

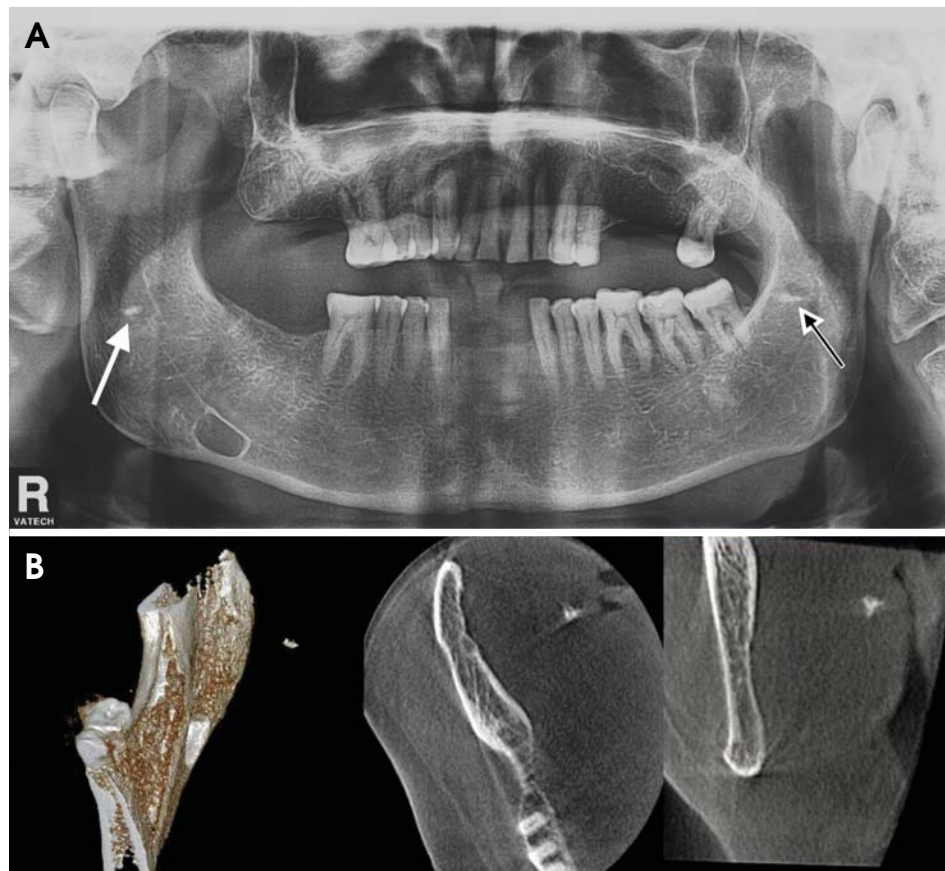


Fig. 3. A. The panoramic radiograph shows a patient with a pseudo-bilateral tonsillolith. The white arrow shows a unilateral calcification that overlapped the middle portion of the ascending ramus. The white and black arrow indicates a ghost image of the radiopacity on the right side appearing higher and more blurred than its source on the left side. B. The CBCT images reveal what appeared on panoramic radiographs as bilateral images were in fact unilateral lesions. The 3D, axial, and coronal CBCT images show a unilateral mass of the right side.

dental detection during panoramic radiographic examination.

In three cases (Cases 1, 2, and 3 in Table 1), the osseous tissue density of the bilateral images, some of which overlapped the mandibular ramus, suggested benign, intra-ossseous lesions. However, the fact that in case 3, some of the

radiopaque images on the right side did not overlap the ramus led to a probable diagnosis of soft-tissue calcification (Fig. 5).^{4,6,15,17} When a soft-tissue calcification is adjacent to bone, it is sometimes difficult to determine whether the calcification is within the bone or the soft tissue. Radiopaque lesions within the mandibular ramus - such as calci-

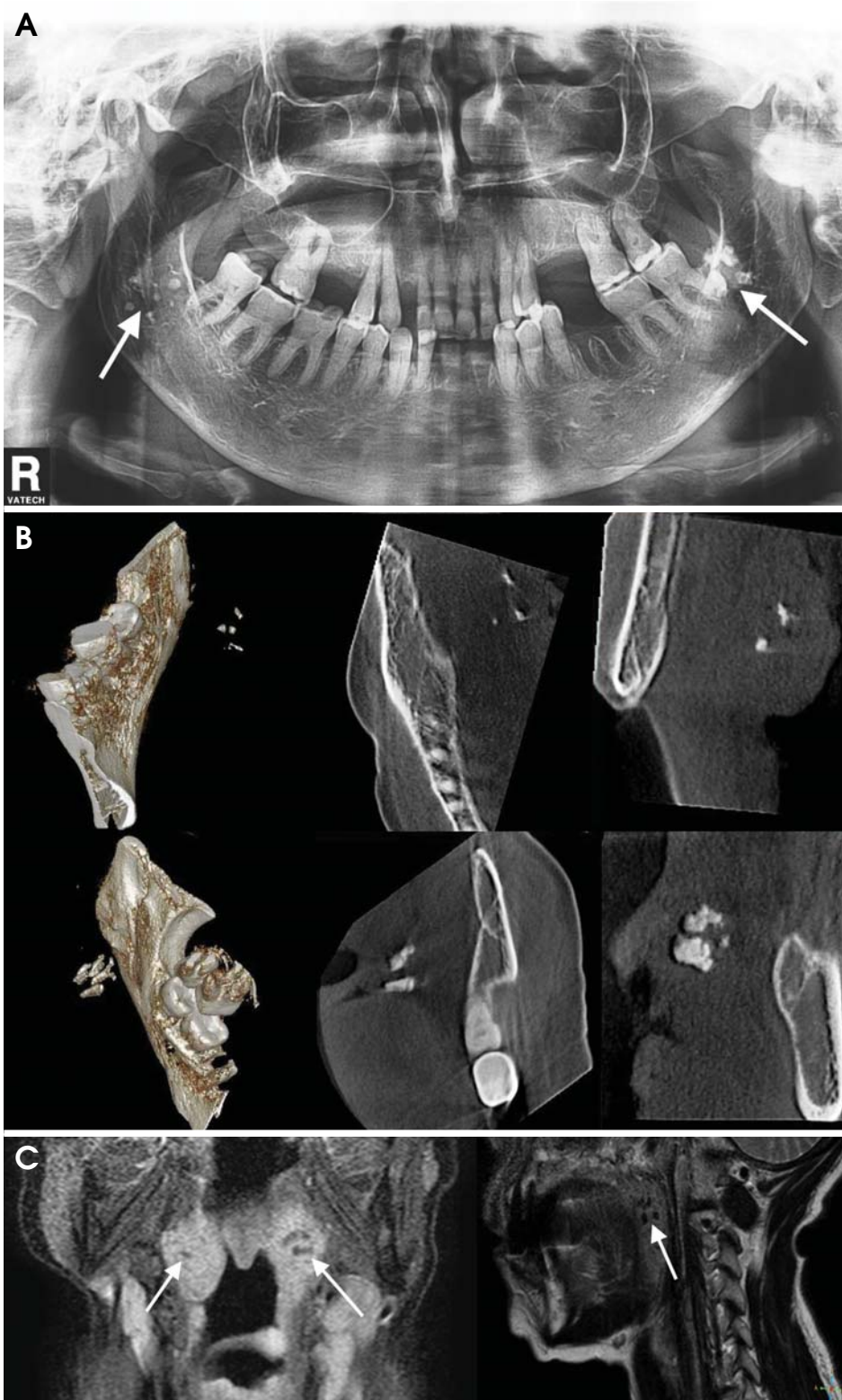


Fig. 4. Case 1. Panoramic, CBCT, and MR images. A. The panoramic radiograph show bilateral calcifications overlapping the middle portion of the ascending ramus, which suggest benign, intra-osseous lesions (white arrows). B. The 3D, axial, and coronal (both sides) CBCT images show bilateral masses in the area of the tonsils. C. The MR images of the same patient show the calcifications in the tonsils (white arrows).

fications in the carotid artery, lymph nodes, salivary gland, and stylohyoid ligament - may be considered in the essential differential diagnosis. In panoramic images, calcifications within the carotid artery appear in the soft tissue

below the angle of the mandible and between the hyoid bone and the cervical spine. Lymph node calcifications occur most often in the submandibular region, near or below the mandibular angle. The majorities (83-94%) of

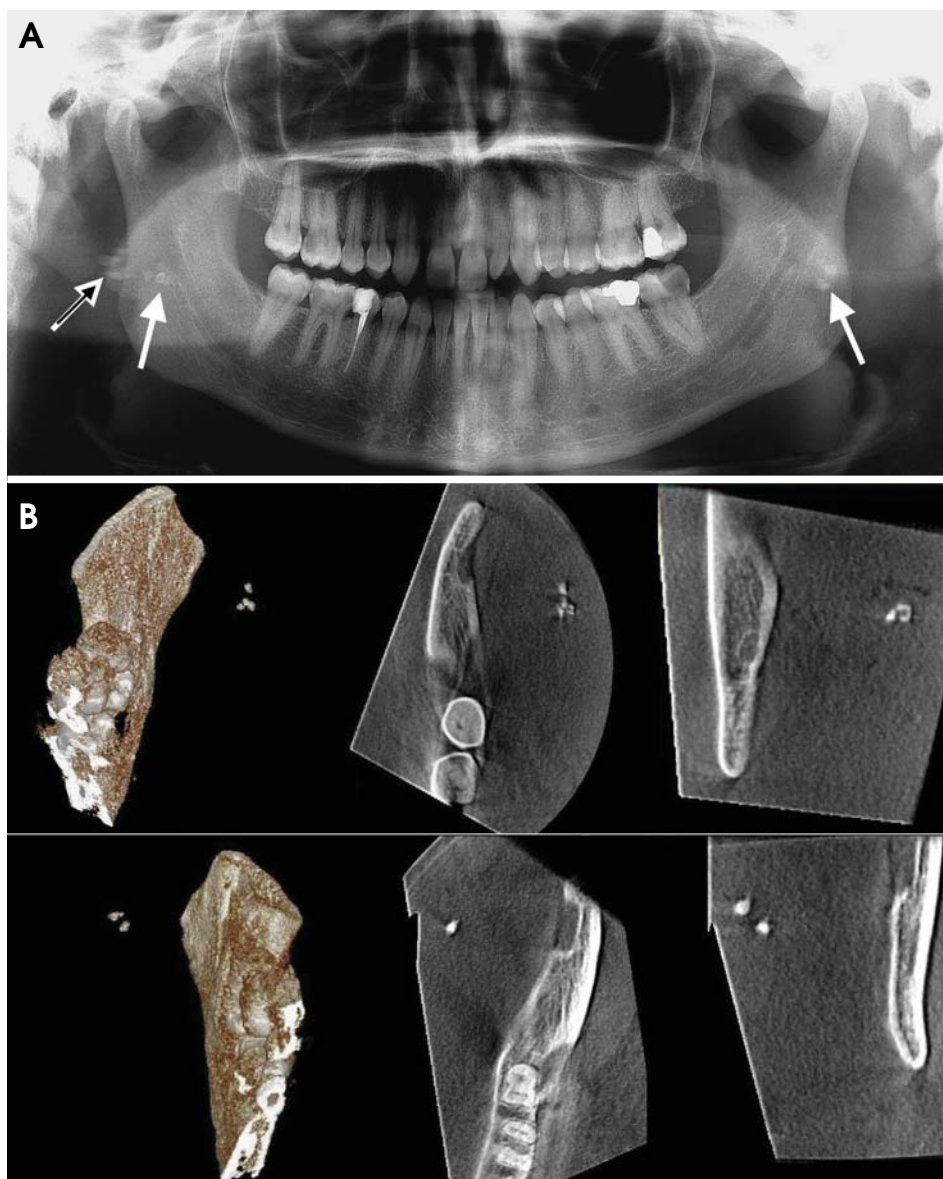


Fig. 5. A. The panoramic radiograph of a patient shows bilateral tonsilloliths. The white and black arrow indicates that some of the radiopaque images on the right side, which do not overlap the ramus, led to a probable diagnosis of soft-tissue calcification. B. CBCT images revealed that they were ghost images of radiopacities on the left side.

sialoliths are found in the submandibular glands, although some occur in the parotid gland (4-10%) or sublingual gland (1-7%) and can be visualized on standard occlusal projections as well as panoramic radiographs. Ossification of the stylohyoid ligament can be seen in a panoramic image to extend from the mastoid process across the postero-inferior aspect of the ramus toward the hyoid bone.¹⁷⁻²⁰

Tonsilloliths can be diagnosed through clinical presentation, physical examination, and image studies. Enlargement and hardening of the tonsil are typical findings during physical examination. On extraoral radiographs, a tonsillolith produces a radiopaque shadow that may be mistaken for a foreign body, tooth, prominent mandibular ramus, or maxilla, or a calcification in an artery, lymph node, salivary gland, or styloid ligament. Differentiation of these

calcifications can be made from a panoramic radiograph supplemented by a CT scan.¹⁷ MRI may also prove valuable in establishing a definitive diagnosis.⁴

The serial images provided by a CT scan make it possible to identify the relationship between the lesion and the surrounding structures and to rule out diagnoses of bony tissue or calcification in vessels. MR images with excellent soft tissue contrast resolution are also most helpful for identifying and localizing orofacial soft tissue lesions. However, their high cost and relatively long imaging times limit the routine use of MRI.¹¹ The compact design and low cost of most CBCT systems relative to conventional CT and MRI has made CBCT a valuable tool for the localization and differentiation of various radiopaque lesions.⁹ In the 7 cases reported here, CBCT was necessary

for a diagnosis of tonsilloliths.

In conclusion, tonsilloliths can be detected on panoramic radiography, but differentiating these lesions from other calcifications and ghost images can be difficult. A CBCT scan is very helpful for identifying the lesions. Asymptomatic, single, and large tonsilloliths should be removed because they can invite recurrent episodes of tonsillitis. Manual compression, curettage, or a simple incision to release the calcified body are usually successful. However, removal of numerous, relatively small asymptomatic tonsilloliths can only be accomplished via a bilateral tonsillectomy.¹⁰ In such cases, the true location of calcifications should be detected with CBCT first. Then the patient should undergo surgery to eliminate symptoms, and after the surgery, histological analysis should be made for achieving a definitive diagnosis.

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