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Original Article

# The prevalence and distribution of radiopaque, calcified pulp stones: A cone-beam computed tomography study in a northern Taiwanese population

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**Abstract** *Background/purpose:* Presence of pulp stones increase the difficulty of locating canal orifice during endodontic treatment. This study aims to determine the prevalence of pulp stones in a northern Taiwanese population through analysis of cone beam computed tomography (CBCT).
*Materials and methods:* A total of 144 patients and 2554 teeth were used in the present study which were collected from a CBCT image archive. To determine the presence of pulp stones, images of pulp chamber and root canals were analyzed in the sagittal, axial and coronal planes and from the occlusal to apical direction. Correlations between pulp stones and gender, age, tooth type, dental arch or side were also examined.
*Results:* Of the 144 patients, 120 patients (83.3%) and 800 (31.3%) teeth were found to have one or more pulp stones through CBCT examination. Prevalence of pulp stones between dental arches and tooth types were significantly different ($P < 0.001$). Pulp stones were found to be the most prevalent in first molars (50.0%) and most scarce in first premolars (18.8%). There was no significant correlation between pulp stones and gender, increasing age, or dental sides.
*Conclusion:* Pulp stones are more frequent in maxillary teeth compared to mandibular teeth. Pulp stones in molar teeth were significantly more common than premolars and incisors. CBCT could be a sensitive tool to detect pulp stones, especially simplifying identification of pulp stones in radicular pulp. Knowledge of pulp stones distribution can aid dentists in clinical endodontic treatment.

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## Introduction

Successful endodontic treatment hinges on the ability to accurately locate, clean, shape, and obturate the three-dimensional root canal system.[1] Pulp calcification presents difficulties in endodontic treatment: canal orifices may be obscured which increases the difficulty of pulp chamber access and the risk of instrument breakage.

Calcified structures are fairly common in human dental pulps. The two main morphological forms of pulp calcifications are discrete pulp stones (denticles or pulp nodules) and diffuse calcifications.[2] Pulp stones tend to present themselves more coronally as discrete and concentric calcifications, while radicular calcifications are more rare and exist more diffusely.[3] Pulp stones may be embedded, attached to dentin walls, or occur freely within the pulp tissue.[4,5] They are found in both deciduous and permanent teeth.[6] The exact etiology of pulp stone formation remains unclear,[5] However, several factors that have been implicated in stone formation, including: pulp calcification, aging, orthodontic tooth movement, periodontal disease, various systemic diseases, genetic predisposition, bacterial infection, deep caries, and restorations.[6–13]

Previous studies have reached no consensus regarding prevalence of pulp stones and reported results range from 8% to 90%.[14] Sizes of pulp stones vary from minute particles to masses large enough to obliterate the pulp chamber.[7] In clinical practice, pulp stones can be identified in periapical and bite-wing radiographs. However, pulp stones smaller than 200 μm in diameter are undetectable in these radiographs, therefore actual incidences may be higher.[15]

Conventional radiographs produce only 2-dimensional images of 3-dimensional objects, resulting in the distortion and superposition of anatomic structures such as the zygomatic arch, the floor of maxillary sinus, and obscure root canal anatomy.[16] Cone beam computed tomography (CBCT) scans are becoming more common in clinical practice and have been found to be useful in providing accurate three dimensional anatomic details suitable for diagnosis and treatment planning before endodontic therapy.[17] Furthermore, CBCT was reported to be a sensitive diagnostic method to identify stones compared to digital radiography.[18] Previous studies showed a wide discrepancy in the prevalence of pulp stones in different populations. These variations in prevalence between different populations may be due to ethnic and geographical differences.[19,20] Two recent studies in Brazil used CBCTs for this and revealed the prevalence of pulp stones in people were 55% and 31.9%, respectively.[21,22] However, no study has investigated the prevalence of pulp stones in the Taiwanese population. Therefore, the aims of this study was to determine the prevalence of pulp stones in the Taiwanese population through CBCT analysis and find any connections between pulp stones with gender, age, tooth type, dental side and dental arch.

## Materials and methods

### Image acquisition and confidentiality

All qualified participants in this study were Taiwanese patients from the Department of Dentistry, Tri-Service General Hospital, Taipei, Taiwan. The project and protocol were approved by the Institutional Review Board of Tri-Service General Hospital, National Defense Medical Center (TSGHIRB No. 2-105-05-07). All images were acquired with a CBCT machine (NewTom 5G; QR, Verona, Italy) between January 2012 and December 2013, and were not taken with specific intent to be used in this study. Board-certified radiologists operated the X-ray tube at an accelerated potential of 110 kV peak, with a beam current of 11.94 mA, and automatically adjusted the exposure time according to the area of scanning (about 7 s for a full arch). The field of view was fixed at 30.5 $cm^2$ × 20.3 $cm^2$ and the resolution and separation of each slice was 0.15 mm. The CBCT scans were saved in the Digital Imaging and Communications in Medicine (DICOM) format and encrypted. CBCT images of 199 patients were initially examined but only 144 patients' images qualified for further analysis based on the following inclusion criteria:

The inclusion and exclusion criteria was adapted from previous studies with some modification.[19,21–23]

1. Each subject has at least one fully erupted permanent tooth.
2. Each investigated tooth has the apex fully formed.
3. Radiopaque masses in the pulp chamber or root were diagnosed as pulp stones.

### Exclusion criteria of images

1. Teeth have either: mid root canal treatment, have undergone root canal treatment or have crowns or posts inserted.
2. Unclear or incomplete image due to scattering, or beam-hardening artifact.
3. Deep carious lesion or restorations that invaded pulp chambers which interfere with the reading of images.
4. Third molars

### Morphologic analysis

Qualified images of patients were analyzed in detail using ImplantMax software (HiAim Biomedical Technology, Taipei, Taiwan). The images were re-oriented so that the maxilla was bilaterally symmetric, and the occlusal plane, either in frontal or sagittal view, was parallel to the ground (Fig. 1). A series of images of teeth were analyzed in sagittal, axial, and coronal views of both pulp chambers

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