# Exploring the Diagnostic Radiographic Features of Hyperplastic Dental Follicle, Dentigerous Cyst, and Inflamed Dentigerous Cyst: A Retrospective CBCT Analysis

Noor Hanani Binti Ahmad Damanhuri[*1,2], Kornkamol Kretapirom[2], and Puangwan Lapthanasupkul[3]

[1]Department of Craniofacial Diagnostics & Biosciences, Faculty of Dentistry, National University of Malaysia, Bangi 43600, Malaysia
[2]Oral and Maxillofacial Radiology Department, Faculty of Dentistry, Mahidol University, Bangkok 10400, Thailand
[3]Oral Pathology and Oral Medicine Department, Faculty of Dentistry, Mahidol University, Bangkok 10400, Thailand
[*]Corresponding author, E-mail: hananidamanhuri@gmail.com

**Abstract**

Pericoronal radiolucencies associated with impacted third molars pose diagnostic challenges due to substantial radiographic overlap between hyperplastic dental follicles (HDFs) and dentigerous cysts (DCs), which may lead to inappropriate clinical management. This retrospective study aimed to evaluate the diagnostic value of cone-beam computed tomography (CBCT) in differentiating histologically confirmed HDFs, DCs, and inflammatory dentigerous cysts (IDCs). Sixty-nine CBCT examinations with definitive histopathological diagnoses were analyzed, focusing on pericoronal width, three-dimensional bone expansion, lesion morphology, effects on adjacent structures, and demographic variables. A statistically significant difference in mean pericoronal width was observed among the groups ($F = 3.160$, $p = 0.049$), with IDCs demonstrating the greatest width ($12.40 \pm 7.14$ mm), followed by DCs ($11.58 \pm 4.86$ mm), while HDFs exhibited the smallest dimensions ($4.70 \pm 1.87$ mm). Multidirectional bone expansion was significantly associated with cystic pathology, including buccolingual ($p = 0.006$), anteroposterior ($p = 0.019$), and superior–inferior expansion ($p = 0.004$), and was absent in all HDF cases. No significant associations were identified between histopathological diagnosis and demographic variables or other CBCT features. The study demonstrated that multidirectional bone expansion and increased pericoronal width on CBCT are the most consistent measures of cystic pathology associated with impacted third molars. Increased expansion in inflamed dentigerous cysts should be used to differentiate between inflamed and non-inflammatory cysts for treatment decision-making.

***Keywords***: *Impacted third molar, Hyperplastic dental follicle, Dentigerous cyst, Inflamed dentigerous cyst, Cone-beam computed tomography (CBCT).*

## 1. Introduction

Cone-beam computed tomography (CBCT) aids in distinguishing dentigerous cysts (DCs) from hyperplastic dental follicles associated with impacted third molars by evaluating the size and morphology of pericoronal radiolucencies. Typically, DCs appear as well-formed, unilocular radiolucencies surrounding the crown of an impacted tooth. Previous studies indicate that the follicular widths exceed 2-3mm, while hyperplastic follicles present smaller and less pathological radiolucencies (Li et al., 2022). DCs' histological makeup is that of a fibrous cyst wall, with squamous epithelium lining, and in some cases, inflammation. Hyperplastic follicles, however, only demonstrate normal connective tissue that exhibits little inflammation and does not present true cyst formations (Austin & Nelson, 2021). There is rationality in the notion that follicles with widths exceeding 2-3mm on CBCT imply increased inflammatory and cystic changes, warranting surgical treatment of the larger lesions (Menditti et al., 2023). The combination of histopathological analysis with CBCT is said to be more accurate for differentiating lesions and aggressive odontogenic lesions. It is also said to assist in managing the clinical aspect of the case (Almeida et al., 2024; Dutta et al., 2025). An impacted third molar is one of the more common dental obstructions noted during dental check-ups. It is estimated that the incidence of such cases is around 36.9%. This occurrence is said to be most common in Asia with an incidence of 43.1% (Pinto et al., 2024). The aetiology of impacted third molars remains unclear; however, certain risk factors include genetic inheritance, dietary factors, and anatomical variants (Ahmad et al., 2021). Among those factors, anatomical factors such as jaw size are often cited as the main causative factor, especially in the mandible, due to the presence of the mandibular ramus, which restricts the space for the third mandibular molar to erupt normally (Yasa et al., 2025). The prevalence of impacted third molars in females may be associated with a higher percentage of smaller jaw size and limited retromolar space than in male patients (Ahmad et al., 2021). Marchiori et al. (2025) also found that the developmental age of the third molar is highly associated with third molar impaction, with later development increasing the likelihood of impaction (Marchiori et al., 2025).

Even though an impacted third molar is often an incidental finding, it may be the nidus of a pathological lesion, which includes root resorption of the adjacent tooth, caries, and periodontal disease of the adjacent tooth, and the development of an odontogenic cyst (Scapini & Mesquita, 2025). The development of an odontogenic cyst associated with an impacted third molar is typically visualized as a pericoronal radiolucency encapsulating the crown of the impacted third molar, with a dentigerous cyst being the most commonly encountered (De Campos et al., 2025). Pericoronal radiolucency may be manifested as a normal, hyperplastic dental follicle, an odontogenic cyst, or an odontogenic tumour. However, hyperplastic dental follicle and dentigerous cysts may clinically and radiologically overlap, confounding diagnosis and treatment planning. Both entities usually appear as well-defined, unilocular radiolucencies encircling the crown of an unerupted tooth and are frequently asymptomatic. In the past, a pericoronal radiolucent width threshold of 5 mm has been used to differentiate the hyperplastic dental follicle from a dentigerous cyst (Schmitd et al., 2014).

In addition to dentigerous cysts and hyperplastic dental follicles, inflamed dentigerous cysts (IDCs) constitute an important part of pericoronal lesions. This is because inflammatory processes can significantly influence cystic behavior by promoting epithelial proliferation, increasing osmotic pressure, enhancing bone resorption through inflammatory mediators, and further initiating dysplastic changes in surrounding cells(Choi & Myers, 2008).

Panoramic radiography remains the most common screening tool for impacted teeth. However, its inherent constraints, including two-dimensional projection, magnification, geometric distortion, and anatomical superimposition, hinder precise evaluation of lesion size, expansion in 3 directions, and the effects of the lesion on surrounding structures. These shortcomings may lead to diagnostic uncertainty and uneven therapeutic choices (Shukla et al., 2022).

Cone-beam computed tomography (CBCT) has become a useful imaging modality for evaluating impacted teeth and related disorders. It provides a three-dimensional view with high spatial resolution and lower radiation dose than regular multidetector CT. CBCT facilitates a thorough evaluation of pericoronal radiolucencies, encompassing accurate measurement of lesion dimensions, assessment of bucco-lingual expansion, cortical thinning or perforation, internal architecture, and impacts on adjacent structures, including the inferior alveolar canal or maxillary sinus (Lim et al., 2018).

Even with these benefits, distinguishing dentigerous cysts from hyperplastic dental follicles on radiographs remains difficult, and there are no widely accepted CBCT criteria that can do so without histological confirmation. Consequently, comprehensive radiographic histopathological correlation is essential to refine diagnostic criteria and optimize evidence-based care for pericoronal radiolucencies associated with impacted third molars. The objective of this study is to assess and compare the CBCT characteristics of dentigerous cysts and hyperplastic dental follicles related to impacted third molars, in conjunction with histological diagnosis.

## 2. Objectives

1) To study the prevalence of dentigerous cysts, inflamed dentigerous cysts, and hyperplastic dental follicle associated with unilocular radiolucencies encapsulating impacted third molars.
2) To evaluate the CBCT features of dentigerous cysts, inflamed dentigerous cysts, and hyperplastic follicle associated with impacted third molars.

## 3. Materials and Methods

The Institutional Review Board, Faculty of Dentistry/Faculty of Pharmacy, Mahidol University, reviewed and approved this retrospective study (MU-DT/PY-IRB 2025/ 088.2611). This retrospective observational study used cone-beam computed tomography (CBCT) data retrieved from the Faculty of Dentistry, Mahidol University's Patient Data Management System (PDMS). The data were collected from two clinical sites, namely the Dental Hospital, Phayathai Campus, and the Maha Chakri Sirindhorn Dental Hospital, Salaya Campus, covering cases from the year 2013 to 2025. All CBCT scans demonstrating impacted third molars associated with pericoronal radiolucent lesions were identified and screened. Cases were included only if they had definitive histopathological diagnoses and showed no evidence of prior surgical intervention such as biopsy, marsupialization, or decompression. Only cases with histopathological confirmation of dentigerous cyst (DC) or hyperplastic dental follicle (HDF) were included in the analysis. After applying these criteria, 69 cases were selected for evaluation.

CBCT images were obtained with a 3D Accuitomo unit (J. Morita, Kyoto, Japan) using standard exposure protocols for dentoalveolar imaging. Image interpretation was performed on a high-definition medical-grade monitor (Eizo MX317W, Japan) in a controlled ambient lighting environment to ensure optimal visualization of fine details. Each lesion was assessed based on several predefined radiographic parameters:

- The pericoronal width was measured from the occlusal surface of the impacted third molar to the outermost radiolucent border at its maximum dimension.
- The location of the lesion was categorized as either maxillary or mandibular.
- The border configuration was classified as smooth, scalloped, or irregular, while the periphery was described as corticated, non-corticated, or sclerotic.
- The internal structure was evaluated for the presence or absence of internal calcifications.
- The relationship between the lesion and the impacted tooth was recorded as one of three types: located at the cementoenamel junction (CEJ), extending beyond the CEJ, or enclosing the entire crown or the full length of the tooth.
- Effects on surrounding structures, including root resorption, displacement of adjacent teeth, bone perforation, inferior alveolar nerve displacement or perforation, and maxillary sinus displacement or perforation, were noted as either present or absent.
- Bone expansion was assessed in three planes: anteroposterior, superior-inferior, and buccolingual/buccopalatal.

Statistical analyses were conducted using IBM SPSS Statistics for Windows, version 29.0 (IBM Corp., Armonk, NY, USA). Qualitative variables were analyzed using the Chi-square test, while quantitative variables were compared using one-way analysis of variance (ANOVA). A p-value of less than 0.05 was considered statistically significant in all tests.

## 4. Results and Discussion

### *4.1. Results*

A total of 69 unilocular pericoronal radiolucencies related to impacted third molars, including dentigerous cysts (DC; n = 14), inflamed dentigerous cysts (IDC; n = 50), and hyperplastic dental follicles (HDF; n = 5), to identify the CBCT features that could reliably differentiate cystic pathology from benign follicular enlargement. As shown in Table 1, the mean age did not differ significantly among the three diagnostic groups ($p = 0.337$). Although patients with IDC showed a slightly higher mean age (44.16 ± 15.60 years) compared with those with DC (42.07 ± 11.35 years) and HDF (34.00 ± 14.49 years), age was not significantly associated with histopathological diagnosis.

Likewise, gender and jaw location were not significantly associated with lesion category (Table 2). A moderate male predominance was detected overall (55.1%); gender distribution was not significantly different between DC, IDC, and HDF ($p = 0.678$). The majority of lesions were in the mandible (89.9%), indicative of the prevalence and long-term impaction of mandibular third molars, but the location of lesions was not associated with histopathological diagnosis ($p = 0.592$).

**Table 1** The prevalence of dentigerous cyst, inflamed dentigerous cyst, and hyperplastic dental follicle associated with the age of the patient.

| Variable | Group | n | Age | | |
|---|---|---|---|---|---|
| | | | Mean (SD) | F-Statistic | p - value |
| Histopathological diagnosis | Dentigerous Cyst | 14 | 42.07 (11.351) | 1.107 | 0.337 |
| | Inflamed Dentigerous Cyst | 50 | 44.16 (15.604) | | |
| | Hyperplastic Dental Follicle | 5 | 34.00 (14.491) | | |

**Table 2** The prevalence of dentigerous cyst, inflamed dentigerous cyst, and hyperplastic dental follicle associated with the gender and location.

| Variable | | Histopathological diagnosis | | | Total n (%) | Chi-Square ($\chi^2$) | p - value |
|---|---|---|---|---|---|---|---|
| | | Dentigerous Cyst n (%) | Inflamed Dentigerous Cyst n (%) | Hyperplastic Dental Follicle n (%) | | | |
| Gender | | | | | | | |
| | Male | 7 (10.1) | 29 (42.0) | 2 (2.9) | 38 (55.1) | 0.778 | 0.678 |
| | Female | 7 (10.1) | 21 (30.4) | 3 (4.3) | 31 (44.9) | | |
| Location | | | | | | | |
| | Maxilla | 2 (2.9) | 4 (5.8) | 1 (1.4) | 7 (10.1) | 1.048 | 0.592 |
| | Mandible | 12 (17.4) | 46 (66.7) | 4 (5.8) | 62 (89.9) | | |

Quantitatively, pericoronal width showed a statistically significant difference between diagnostic groups (Table 3; ANOVA, F = 3.160, p = 0.049). IDC had the highest mean pericoronal width (12.40 ± 7.14 mm), followed by DC (11.58 ± 4.86 mm), and HDF showed consistently smaller measurements (4.70 ± 1.87 mm).

**Table 3** The association of pericoronal width with its corresponding histopathological diagnosis.

| Variable | Group | n | Age | | |
|---|---|---|---|---|---|
| | | | Mean (SD) | F-Statistic | p - value |
| Histopathological diagnosis | Dentigerous Cyst | 14 | 11.58 (4.862) | 3.160 | 0.049 |
| | Inflamed Dentigerous Cyst | 50 | 12.40 (7.138) | | |
| | Hyperplastic Dental Follicle | 5 | 4.70 (1.872) | | |

The majority of CBCT features (lesion border, periphery, internal calcifications, relationship to the impacted tooth, tooth displacement, root resorption, bone perforation, nerve displacement, nerve perforation, and sinus perforation) were not significantly associated with histopathological diagnosis (Table 4; p > 0.05). However, multidirectional bone expansion, a key discriminator, showed a strong, statistically significant association with cystic disease (Table 4). Buccolingual expansion (p = 0.006), anteroposterior expansion (p = 0.019), and superior-inferior expansion (p = 0.004) were almost exclusively seen in DC and IDC, with no bone expansion in any dimension of the HDF.

**Table 4** CBCT features according to the histopathological diagnosis

| Variable | | Histopathological diagnosis: Dentigerous Cyst n (%) | Inflamed Dentigerous Cyst n (%) | Hyperplastic Dental Follicle n (%) | Total n (%) | Chi-Square ($\chi^2$) | p - value |
|---|---|---|---|---|---|---|---|
| Border | | | | | | | |
| | Smooth | 13 (18.8) | 33 (47.8) | 5 (7.2) | 51 (73.9) | 6.129 | 0.190 |
| | Irregular | 0 (0.0) | 5 (7.2) | 0 (0.0) | 5 (7.2) | | |
| | Scalloped | 1 (1.4) | 12 (17.4) | 0 (0.0) | 13 (18.8) | | |
| Periphery | | | | | | | |
| | Corticated | 11 (15.9) | 33 (47.8) | 4 (5.8) | 48 (69.6) | 6.854 | 0.144 |
| | Non-Corticated | 2 (2.9) | 2 (2.9) | 1 (1.4) | 5 (7.2) | | |
| | Sclerotic | 1 (1.4) | 15 (21.7) | 0 (0.0) | 16 (23.2) | | |
| Presence of calcification | | | | | | | |
| | No | 13 (18.8) | 45 (65.2) | 5 (7.2) | 63 (91.3) | 0.626 | 0.731 |
| | Yes | 1 (1.4) | 5 (7.2) | 0 (0.0) | 6 (8.7) | | |
| Relationship with impacted tooth | | | | | | | |
| | CEJ Level | 13 (18.8) | 48 (69.6) | 5 (7.2) | 66 (95.7) | 1.556 | 0.817 |
| | Beyond CEJ Level | 1 (1.4) | 1 (1.4) | 0 (0.0) | 2 (2.9) | | |
| | Enclosing the Entire Length of the Tooth | 0 (0.0) | 1 (1.4) | 0 (0.0) | 1 (1.4) | | |
| Displacement of the adjacent tooth | | | | | | | |
| | No | 13 (18.8) | 39 (56.5) | 5 (7.2) | 57 (82.6) | 2.815 | 0.245 |
| | Yes | 1 (1.4) | 11 (15.9) | 0 (0.0) | 12 (17.4) | | |
| Root resorption of the adjacent tooth | | | | | | | |
| | No | 7 (10.1) | 33 (47.8) | 5 (7.2) | 45 (65.2) | 4.109 | 0.128 |
| | Yes | 7 (10.1) | 17 (24.6) | 0 (0.0) | 24 (34.8) | | |
| Bone expansion (Buccolingual) | | | | | | | |
| | No | 4 (5.8) | 15 (21.7) | 5 (7.2) | 24 (34.8) | 10.117 | **0.006*** |
| | Yes | 10 (14.5) | 35 (50.7) | 0 (0.0) | 45 (65.2) | | |
| Bone expansion (Anteroposterior) | | | | | | | |
| | No | 7 (10.1) | 18 (26.1) | 5 (7.2) | 30 (43.5) | 7.880 | **0.019*** |
| | Yes | 7 (10.1) | 32 (46.4) | 0 (0.0) | 39 (56.5) | | |
| Bone expansion (Superoinferior) | | | | | | | |
| | No | 3 (4.3) | 15 (21.7) | 5 (7.2) | 23 (33.3) | 11.143 | **0.004*** |
| | Yes | 11 (15.9) | 35 (50.7) | 0 (0.0) | 46 (66.7) | | |
| Bone Perforation | | | | | | | |
| | No | 5 (7.2) | 29 (42.0) | 4 (5.8) | 38 (55.1) | 3.549 | 0.170 |
| | Yes | 9 (13.0) | 21 (30.4) | 1 (1.4) | 31 (44.9) | | |
| Nerve Displacement | | | | | | | |
| | No | 6 (9.0) | 21 (31.3) | 4 (6.0) | 31 (46.3) | 4.940 | 0.085 |
| | Yes | 8 (11.9) | 28 (41.8) | 0 (0.0) | 36 (53.7) | | |
| Nerve Perforation | | | | | | | |
| | No | 8 (11.9) | 25 (37.3) | 4 (6.0) | 37 (55.2) | 3.614 | 0.164 |
| | Yes | 6 (9.0) | 24 (35.8) | 0 (0.0) | 30 (44.8) | | |
| Sinus Perforation | | | | | | | |
| | No | 1 (14.3) | 0 (0.0) | 1 (14.3) | 2 (28.6) | 4.550 | 0.103 |
| | Yes | 1 (14.3) | 4 (57.1) | 0 (0.0) | 5 (71.4) | | |

***4.2 Discussion***

Pericoronal radiolucencies related to impacted third molars can range from benign follicular proliferation to genuine cystic disease. Occasionally, it is still difficult to distinguish hyperplastic dental follicles (HDFs), dentigerous cysts (DCs), and inflamed dentigerous cysts (IDCs), as typical imaging findings often overlap among these entities. In the present study, the quantitative and three-dimensional CBCT parameters demonstrated potential as diagnostic markers that may improve the correlation between radiographic findings and histopathological diagnosis and enhance lesion characterization.

Demographic characteristics such as age, gender, and jaw location showed no significant association with histopathological diagnosis in the present study population. This finding is consistent with previous reports indicating that impaction patterns and demographic distributions are primarily related to anatomical and developmental factors rather than the biological behavior of pericoronal lesions (Eninanç & Mavi, 2024; Huang et al., 2019)

Pericoronal width showed significant differences in mean width among diagnostic groups, with IDCs having the highest mean width, followed by DCs, and HDFs consistently exhibiting smaller dimensions across all groups. These findings provide important diagnostic value and are consistent with previous literature suggesting a 5 mm pericoronal width as a cutoff for distinguishing a hyperplastic dental follicle from cystic changes within the lesion (Schmitd et al., 2014). Bone expansion occurs in response to prolonged hydrostatic pressure and biologically induced bone remodelling, features common to true cystic lesions but absent in benign follicular enlargement (Mustansir-Ul-Hassnain et al., 2021). Nevertheless, considerable overlap in pericoronal width, between lesions, together with the presence of relatively narrow cystic lesions, indicates that size criteria alone may be insufficient for reliable differentiation between DC and IDC. This aligns with the current literature, which demonstrates a high prevalence of pathological changes even in follicles with seemingly normal or minimally enlarged pericoronal spaces. Previous studies have also reported pathological alterations in follicles with normal or minimally enlarged pericoronal spaces (Al-Dumaini & Abbas, 2024; Menditti et al., 2023), indicating that pathology cannot be reliably excluded based solely on radiographic appearance (Vesala et al., 2024). This underscores the need for a more comprehensive radiological and histopathological evaluation, regardless of pericoronal width.

The consistent expansion observed across all three planes highlights the robustness of three-dimensional CBCT imaging as a discriminative diagnostic marker, thereby demonstrating its superiority over panoramic imaging. Radiographically, these results highlight the major limitations of 2D panoramic imaging in assessing pericoronal lesions. Panoramic radiography condenses complex three-dimensional anatomy into a single plane (Perez et al., 2022), which can obscure early bone expansion and underestimate lesion extent, increasing diagnostic uncertainty. As illustrated in Figure 1, dentigerous cysts and hyperplastic dental follicles may have similar radiographic characteristics on panoramic images, including pericoronal width and relationship to adjacent structures. However, CBCT imaging clearly demonstrates multidirectional bone expansion in dentigerous cysts, a feature not observed in hyperplastic dental follicles.

Apart from distinguishing dentigerous cysts from hyperplastic dental follicle associated with an impacted third molar, this study also highlighted the difference between dentigerous cysts and their inflamed counterparts. Although both groups showed similar radiographic patterns, IDCs had wider pericoronal widths and sharper expansion than DCs, suggesting that inflammatory processes were associated with greater cystic growth and bone remodelling (Weber et al., 2019). In addition to increased pericoronal space, IDCs also exhibited more pronounced, scalloped, and sclerotic borders compared with non-inflamed DCs. Peripheral sclerosis most likely indicates a reactive osseous response to ongoing inflammation, whereas scalloping may suggest uneven bone resorption secondary to inflammation as well (Terkawi et al., 2022). These radiographic findings collectively highlight the importance of considering inflammatory influences when interpreting pericoronal radiolucencies associated with impacted third molars. Such features may not be readily detectable in conventional dentigerous cysts, thereby supporting the diagnostic advantage of CBCT in evaluating IDCs. Due to their inflammatory characteristics, the surgical procedure for IDCs can be extensive, and postoperative follow-up may be more intensive than for non-inflamed DCs, whose clinical course is more predictable. A systematic review of published case reports of primary intra-osseous squamous cell carcinoma arising from dentigerous cysts revealed that most cases showed histopathological evidence of chronic inflammatory cell infiltration, predominantly lymphocytes and plasma cells, within the connective tissue of the cyst wall (Halboub et al., 2025). Thus, distinguishing IDC as a separate pathological entity has important implications for management planning and prognostic interpretation.

As such, CBCT provides fundamental diagnostic data by enabling proper assessment of buccolingual, anteroposterior, and superior-inferior expansion (i.e., differences in size and volume, which are often under-detected on panoramic imaging) (Barroso et al., 2023; Dongol et al., 2018). Clinically, this study proposes a CBCT-based diagnostic approach that moves beyond reliance on arbitrary pericoronal width thresholds or single imaging characteristics. Minimal pericoronal enlargement without bone expansion is the best indicator of HDF and thus more suggestive of conservative management. In contrast, lesions demonstrating greater pericoronal width together with multidirectional bone expansion should raise suspicion of cystic pathology and warrant surgical management with histopathological confirmation. This approach may help minimize unnecessary surgical excision of non-pathological follicles while reducing the risk of underdiagnosing clinically significant cystic lesions. Furthermore, identifying bone expansion and pericoronal width as key discriminating features provides a foundation for future research, including the development of AI-based CBCT classification models aimed at enhancing diagnostic accuracy and supporting clinical decision-making in oral and maxillofacial radiology.

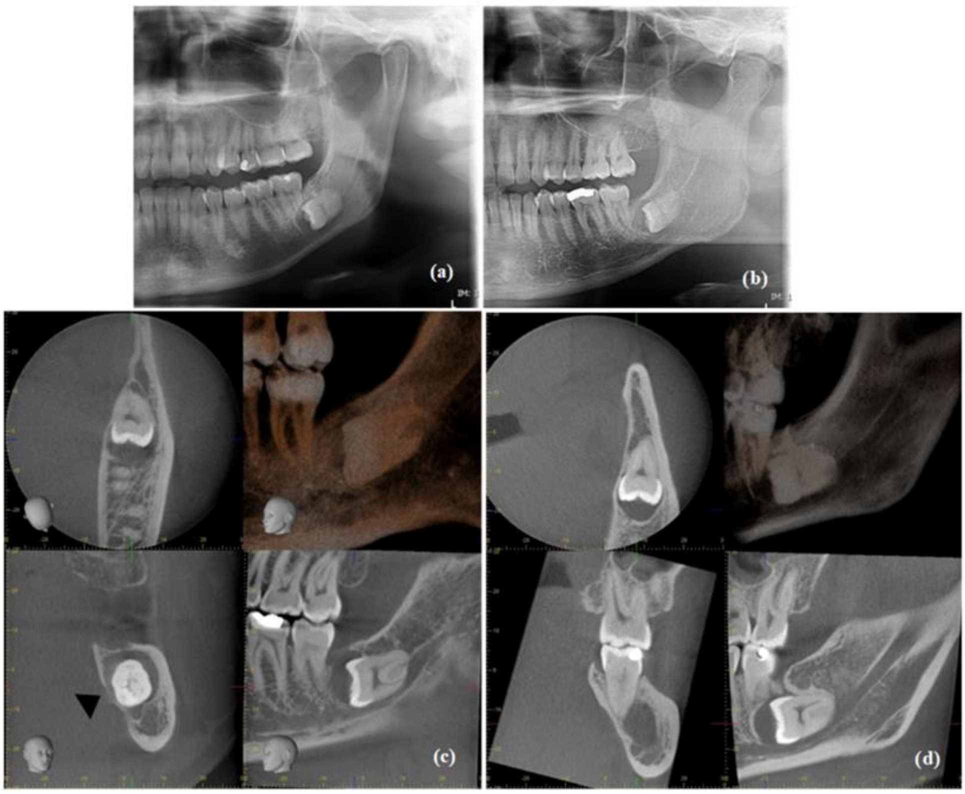


**Figure 1** Cropped panoramic radiographs show that dentigerous cyst (a) and hyperplastic dental follicle (b) may appear identical in terms of pericoronal width and their relationship to nearby structures. However, CBCT shows that dentigerous cysts exhibit distinct bone expansion with thinning of the lingual cortical plate-black arrowhead (c), whereas hyperplastic dental follicles do not (d).

**5. Conclusion**

Cone-beam computed tomography offers crucial three-dimensional information on pericoronal lesions related to impacted third molars. This study demonstrates that multidirectional bone expansion, together with increased pericoronal width, represents the most reliable CBCT indicator of cystic pathology, whereas the absence of these features supports a diagnosis of a hyperplastic dental follicle. Inflamed dentigerous cysts had larger lesion dimensions and greater expansion than dentigerous cysts, underscoring the clinical relevance of distinguishing these entities for accurate diagnosis and proper management. These findings indicate that reliance on two-dimensional imaging or pericoronal width alone is insufficient. Integrating CBCT with histopathological evaluation may improve diagnostic accuracy and support more effective clinical decision-making in the management of pericoronal radiolucency.

**6. Acknowledgements**

The authors would like to express our sincere gratitude to the staff of the Oral and Maxillofacial Radiology Department, Faculty of Dentistry, Mahidol University, for their assistance with data collection and CBCT image interpretation. The authors also thank the Department of Oral Pathology and Oral Medicine, Faculty of Dentistry, Mahidol University, for their invaluable support in histopathological diagnoses.

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