CASE REPORT

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Incidental radiography findings of variations in root morphology: dens invaginatus or vertucci's

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ABSTRACT

Objectives: The objective of this case report is to document the incidental finding in tooth 34 through panoramic radiography and discuss whether it falls into the category of dens invaginatus or Vertucci's root canal morphology variations.

Case Report: A 13-year-old male patient presented to RSGMP UNHAS with complaints of a decayed and painful lower left back tooth. Clinical examination revealed deep caries with perforation in tooth 35, and a periapical abscess was diagnosed. Panoramic and periapical radiographs were taken for diagnostic purposes. Radiographic analysis focused on identifying variations in the root morphology of adjacent teeth, specifically tooth 34.

Conclusion: The incidental finding in tooth 34 through panoramic radiography emphasizes the importance of routine radiographic examinations in clinical practice. Early diagnosis and a clear understanding of this dental developmental anomaly are vital to ensuring the patient's optimal oral health outcomes.

Keywords: *Dens invaginatus, Vertucci's, incidental finding, panoramic radiography*
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INTRODUCTION

Dental anomalies are changes in tooth structure that occur during tooth formation. These anomalies can be congenital, developmental, or acquired. Congenital types are inherited from ancestors and have a genetic basis, while developmental types appear during tooth formation and acquired types occur after tooth formation. Many factors can cause dental anomalies, including environmental and genetic factors. Developmental anomalies are conditions where teeth develop abnormally.[1,2,3] After calcification, invagination in the tooth crown causes dens invaginatus (DI), also known as dens in dente. This is due to the fact that after development, the Hertwig epithelial root sheath folds within the root. Dens invaginatus can be found with a structure resembling a tooth within a tooth. This dental anomaly, also called dens invaginatus (DI) or dens in dente, is believed to be caused by the enamel organ invaginating into the dental papilla before calcification.[4] Partial invagination in type I is limited to the tooth crown. In type II cases, partial invagination extends beyond the cementoenamel junction and reaches the root. Type III lesions extend through the root and communicate without involving the periodontal ligament (PDL).[3] Genetic factors, such as inheritance, metabolism, and mutation, or environmental factors, such as physical, chemical, environmental, and biological elements, can cause developmental anomalies. It is also possible that some of these anomalies are caused by a combination of genetic and environmental factors.[5]

Dens invaginatus, also known as dens in dente, is a developmental anomaly reported in permanent teeth with a frequency of 0.25–10%.[4,5] In most cases, it occurs when the enamel organ invaginates into the dental papilla before the dental tissues mature. Oehlers provided the most common classification for dens invaginatus in 1957. Table 1 and Figure 7 show that, based on this classification, there are three basic types of dens invaginatus.[6] In the diagnosis of dental diseases, two-dimensional periapical and panoramic radiographs are routinely used as valuable diagnostic tools alongside clinical examination. However, three-dimensional imaging techniques such as cone beam computed tomography, magnetic resonance imaging, and ultrasound can overcome some limitations of two-dimensional radiographs.[7]

The aim of this case report is to document incidental findings on tooth 34 through the modality of radiography. To discuss whether the findings represent dens invaginatus or a variation of root morphology.

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CASE REPORT

A 13-year-old male patient came to RSGMP UNHAS with complaints of a painful, decayed lower left back tooth. The general condition was good, with no extraoral abnormalities. Clinical examination revealed deep caries with perforation in tooth 35, and a periapical abscess was diagnosed. Panoramic and periapical radiographs were taken for diagnostic purposes. Radiographic examination revealed an abnormality in the root morphology of tooth 34. Radiographic analysis focused on identifying variations in root morphology in the neighboring tooth, particularly tooth 34.

Figure 1. Extra Oral View

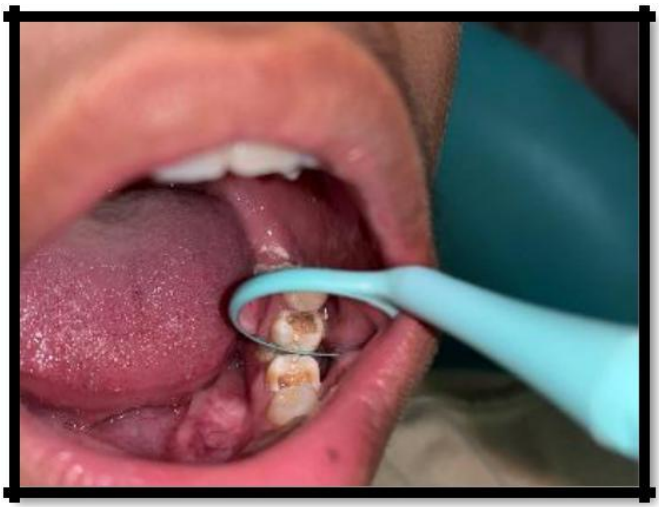

Figure 2. Intraoral view

Periapical radiography of tooth 35 revealed a radiolucent lesion in the periapical region, consistent with the clinical diagnosis of a periapical abscess. At the same time, incidental radiographic findings were identified in tooth 34, suggesting a variation in root morphology. Since tooth 34 is the focus of this case report, the information obtained from the periapical radiograph was complemented by panoramic radiography and further assessed using CBCT for a more detailed evaluation of the root canal configuration.

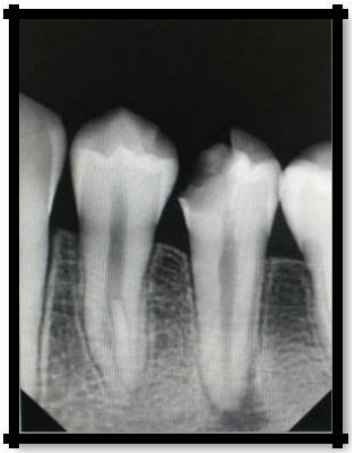

Figure 3. The periapical radiograph of tooth 34 demonstrates an unusual root canal morphology suggestive of canal variation

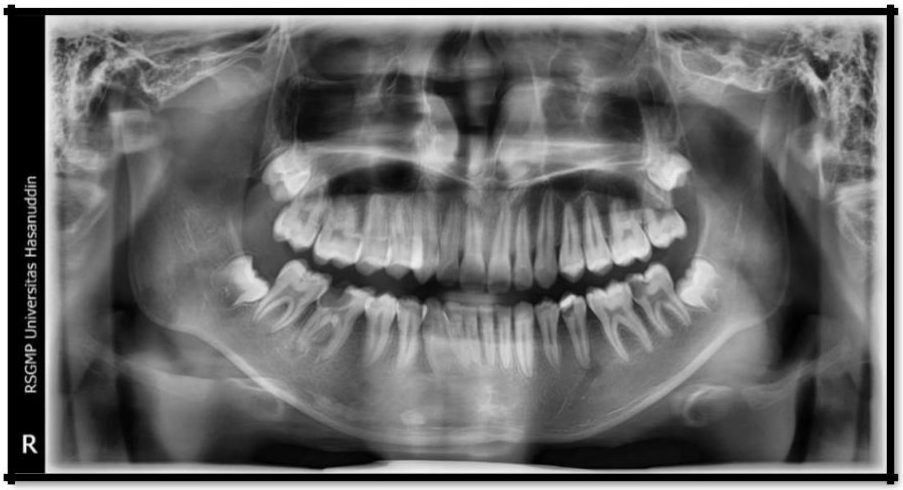

Figure 4. The panoramic radiograph of tooth 34 reveals an unusual root morphology suggestive of root canal variation

DISCUSSION

Most cases of dens invaginatus (DI) are found incidentally during thorough clinical examinations, either through unusual crown shapes like "bulbous," "peg-shaped," or "hourglass," or through radiographs. Pulp involvement can occur due to malformed pulp, allowing irritants to enter. Even without caries, serious complications such as pulp necrosis, periodontitis, or cystic changes can occur. This is because the invagination leads to early pulp death in the tooth. Therefore, early detection and treatment of teeth with DI heavily rely on comprehensive clinical examinations and a good understanding of radiography.[8]

Dens invaginatus is a structural anomaly that can be found in any tooth, but is most commonly observed in maxillary anterior teeth. It manifests in various degrees of severity, ranging from minor changes in tooth structure to significant and complex structural abnormalities. The etiology of invaginated teeth remains unclear. Dens invaginatus may result from various types of pressure exerted on the tooth germ during development, which can compress the enamel organ. These pressures may include adjacent tooth germs, trauma, infection, focal growth retardation of the tooth bud, and constraints within the dental arch.[9] The contour of the enamel is not always visible on radiographs, but dens invaginatus may appear as a narrow or broad, rounded infolding of enamel and dentin.[10] Dentists face difficulties in treating teeth with non-standard anatomy, such as dens invaginatus.[11]

Table 1. Oehlers' classification of dens invaginatus[6]

Type I	Invagination is limited to the crown up to the amelocemental junction
Type II	Invagination extends into the root beyond the cementoenamel junction with no communication with the dental pulp
Type III A	Invagination extends into the root and communicates laterally through a pseudoforamen with the periodontal ligament (PDL) with no pulpal communication
Type III B	Invagination extends into the root and communicates apically through a pseudoforamen with the PDL with no pulpal communication

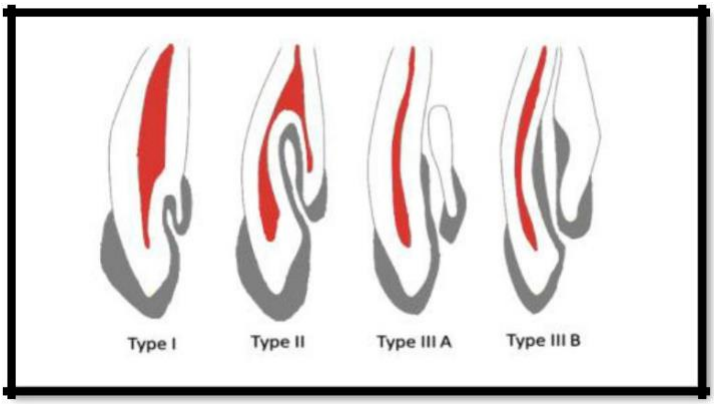

Figure 5. Classification of dens invaginatus

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Vertucci's research in the 1970s and 1980s categorized the number and configuration of root canals into eight types. Factors influencing variations in root canals include ethnicity, age, gender, and study design. Vertucci's data may not represent all ethnicities worldwide, but it provides a good starting point for understanding root canal anatomy.[12]

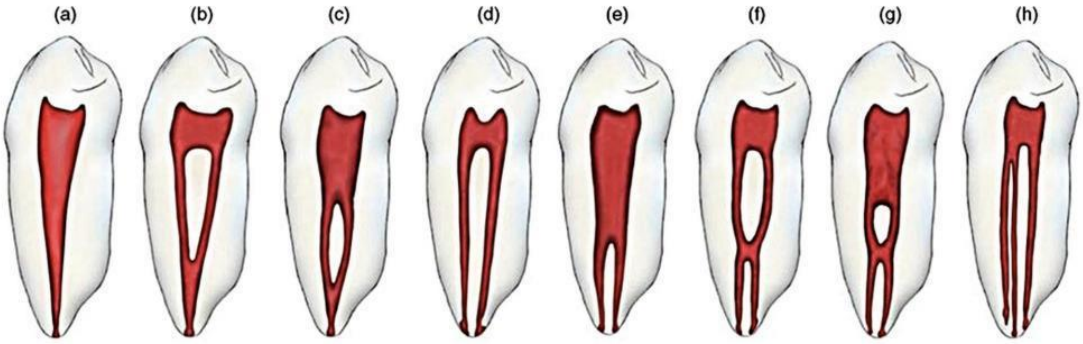

Figure 6. Classification of Vertucci[13]

Vertucci classified root canal morphology into eight types as described below (Figure 6)[14,15], Vertucci classified root canal morphology into eight configurations based on the number and pathway of canals from the pulp chamber to the apex. Type I consists of a single canal extending uninterrupted to the apex. Type II involves two canals leaving the pulp chamber and merging into one before the apex, whereas Type III describes a single canal that divides into two and then rejoins into one. Type IV is characterized by two separate canals extending independently to the apex. In Type V, a single canal leaves the pulp chamber and bifurcates into two distinct canals with separate apical foramina. Type VI shows two canals that merge in the middle third and divide again near the apex. Type VII presents a more complex pattern in which one canal divides, rejoins, and divides again before reaching the apex. Type VIII consists of three separate canals extending from the pulp chamber to the apex.

Since 1984, the Vertucci classification has been widely used to describe root canal morphology. However, some issues have arisen over time, such as the inability to identify two or three rooted teeth and the inability to classify various root canal systems. Due to these limitations of the original Vertucci system, Sert et al. proposed additions in 2004 to describe different root canal morphologies.[13] Dens invaginatus, often found in anterior teeth, is rare in premolars and molars. Root morphology variations according to Vertucci provide crucial guidance in understanding the complexity of root canals and planning endodontic treatment. In this case, an incidental finding in tooth 34 highlights the importance of routine radiography to detect anomalies that may not be clinically apparent.

Using digital panoramic radiography enables the simultaneous examination of teeth and jaws with low radiation doses and low costs. Therefore, for most orthodontic, prosthetic, and dental surgical procedures, this type of radiography is preferred. It can be used to study both normal and abnormal findings, including dental anomalies that sometimes need to be reviewed and monitored.[1]

A cone-beam computed tomography (CBCT) scan was performed on tooth 34 using a field of view (FOV) of 80 × 50 mm to allow a detailed three-dimensional evaluation of the root canal system. The use of CBCT in this case was indicated due to the limitations of conventional two-dimensional radiographs, which were unable to clearly delineate the complexity of the root canal morphology observed on periapical and panoramic images. The presence of an unusual radiographic pattern in tooth 34 raised suspicion of a complex canal configuration that required further assessment to distinguish between a developmental anomaly, such as dens invaginatus, and an anatomical variation of the root canal system. CBCT imaging provided multiplanar visualization, including axial, coronal, and sagittal views, as well as three-dimensional reconstruction of the region of interest. The axial view demonstrated an additional canal in the apical third of the root, smaller than the main canal. Coronal sections revealed a bifurcation of the canal system in the middle third, with two distinct canals extending toward separate apical foramina. Sagittal views further confirmed the division of a single canal into two branches along the root length. Three-dimensional reconstruction supported these findings by clearly illustrating the spatial configuration of the root canal system. Overall, CBCT examination enabled precise characterization of the root canal morphology in tooth 34, confirming a Vertucci Type V configuration and excluding the possibility of dens invaginatus.

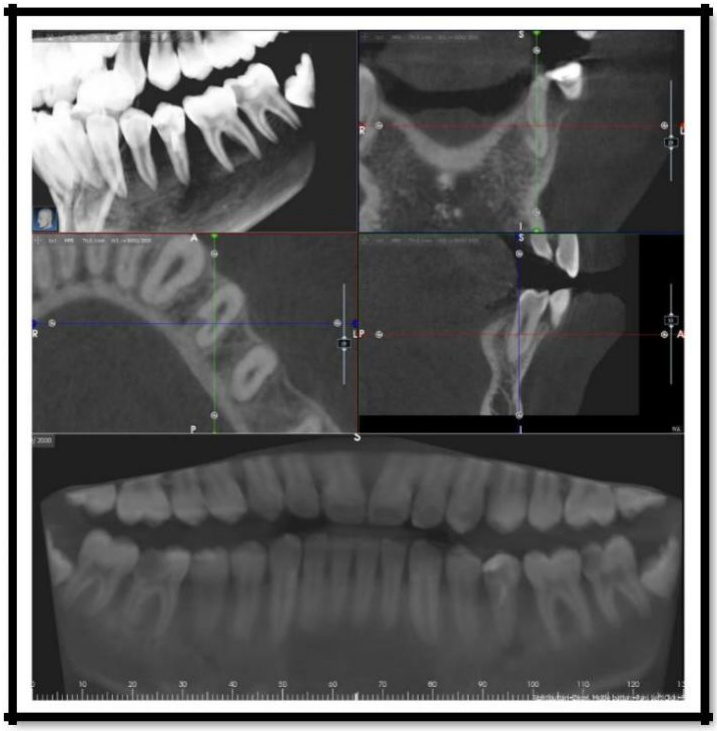

Figure 7. 3D reconstruction, multiplanar view, and panoramic reconstruction focusing on the region of tooth 34

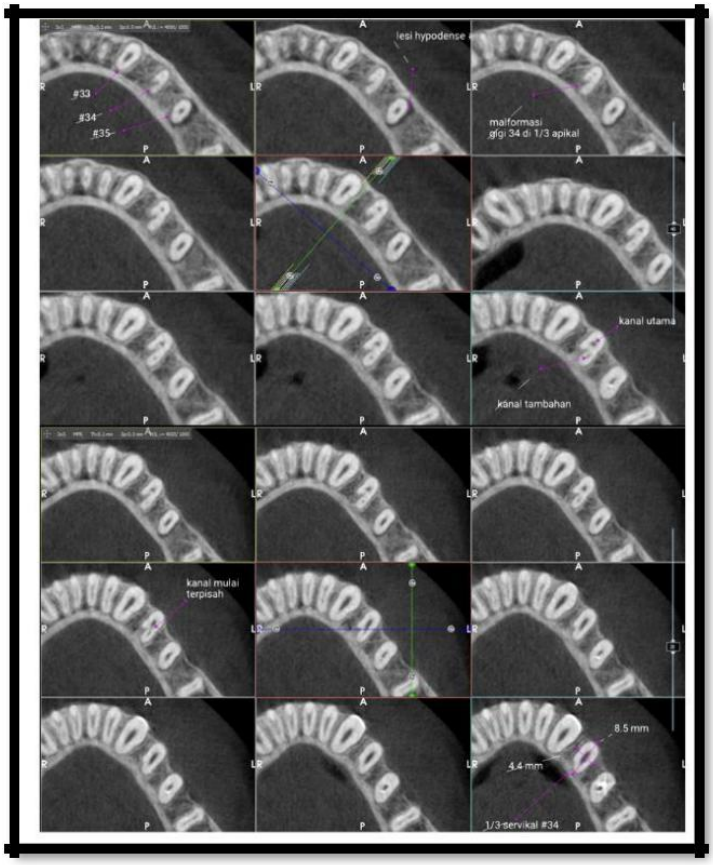

Figure 8. Axial multislice view focusing on the region of tooth 34 (3x6 interval, 0.5 mm)

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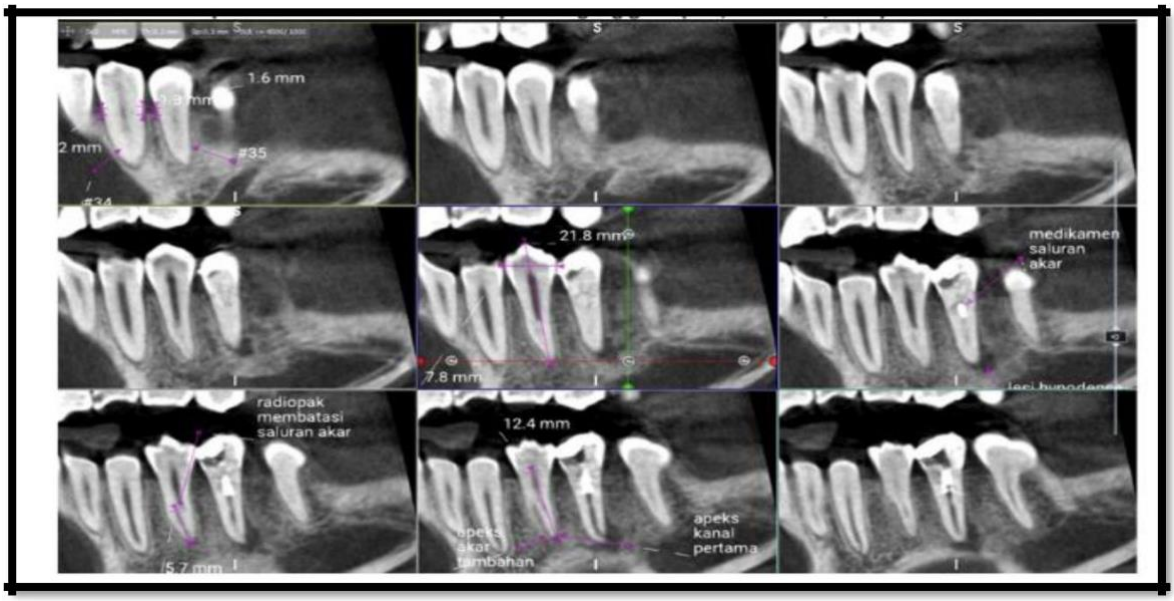

Figure 9. Coronal multislice view focusing on the region of tooth 34

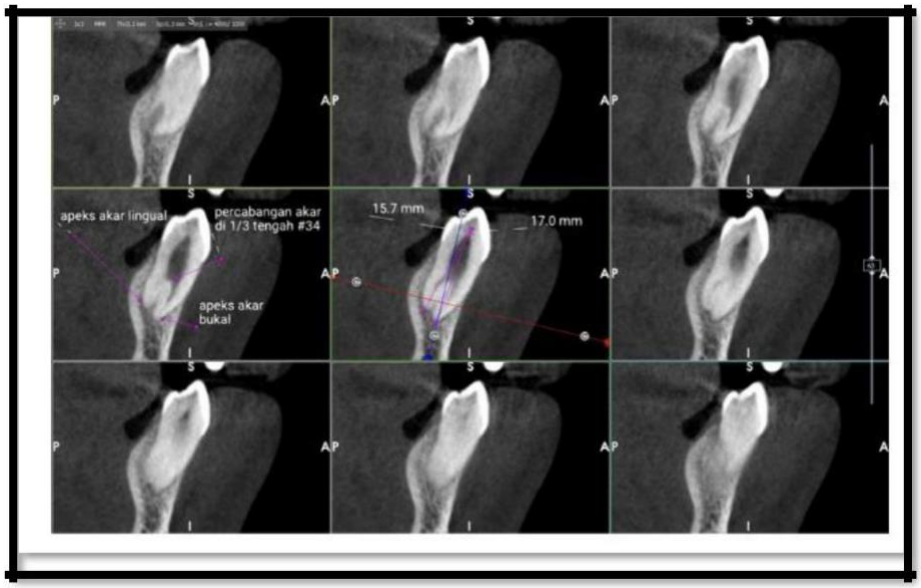

Figure 10. Sagittal multislice view focusing on the region of tooth 34 (3x3, 0.3 mm interval)

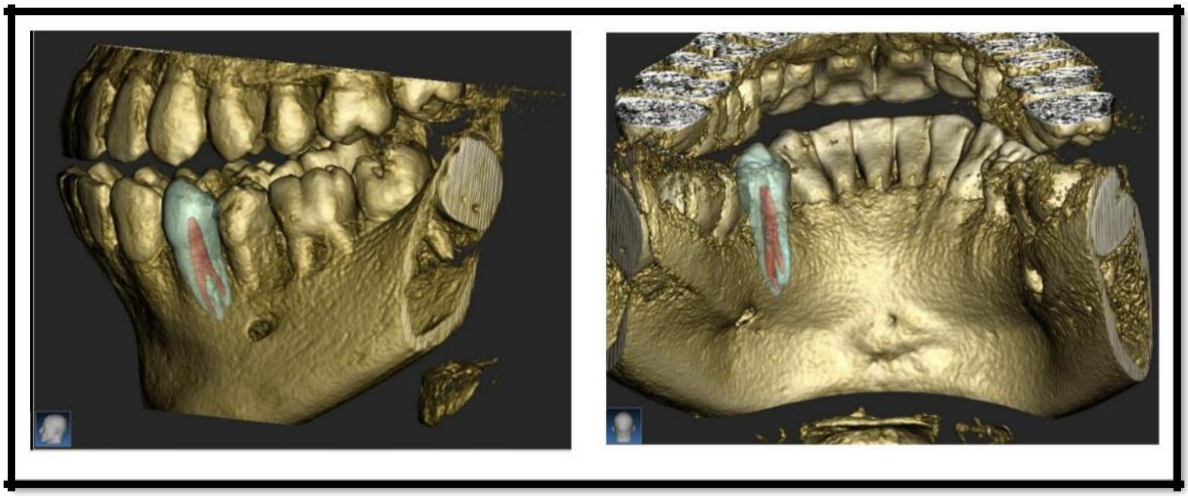

Figure 11. 3D reconstruction view of tooth 34 segmentation simulation (light blue = tooth 34, red = root canal) in bone and x-ray mode

For further analysis, cone-beam computed tomography (CBCT) was performed on tooth 34. The CBCT findings demonstrated that the root canal morphology corresponded to Vertucci Type V configuration, characterized by a single canal originating from the pulp chamber that bifurcates into two distinct canals in the middle to apical third of the root. In this case, the bifurcation was clearly visualized in multiplanar sections, with both canals extending separately toward two distinct apical foramina. The additional canal appeared smaller in diameter compared to the main canal, and both canals were delineated by radiopaque walls consistent with dentin. No evidence of enamel-lined invagination or structural features suggestive of dens invaginatus was observed. These findings confirm that the observed variation represents an anatomical root canal configuration rather than a developmental anomaly. The use of CBCT allowed precise visualization of the canal bifurcation (deep split), which could not be adequately identified on conventional two-dimensional radiographs. Accurate identification of this configuration is essential for appropriate endodontic planning, as failure to recognize additional canals may compromise treatment outcomes.

For further evaluation of the incidental finding in tooth 34, cone-beam computed tomography (CBCT) was performed. The CBCT examination demonstrated that tooth 34 had a root canal configuration consistent with Vertucci Type V, in which a single canal left the pulp chamber and bifurcated into two separate canals with distinct apical foramina in the middle to apical third of the root. No periapical radiolucency or other periapical pathological changes were observed in relation to tooth 34. These findings indicate that the radiographic appearance in tooth 34 represents an anatomical variation in root canal configuration rather than a developmental anomaly such as dens invaginatus. The use of CBCT was essential in this case because conventional two-dimensional radiographs could not adequately demonstrate the three-dimensional course of the canal bifurcation. In contrast, the periapical inflammatory lesion described clinically and radiographically was associated with tooth 35, not tooth 34. Therefore, the interpretation of a chronic periapical abscess or granuloma should be limited to tooth 35 and should not be included in the CBCT interpretation of tooth 34.

CONCLUSION

The incidental finding in tooth 34 was confirmed by CBCT as a Vertucci Type V root canal configuration, characterized by bifurcation of a single canal into two separate canals with distinct apical foramina. This case emphasizes the importance of advanced imaging in identifying complex root canal anatomy and differentiating anatomical variations from developmental anomalies. Accurate radiographic diagnosis is essential for appropriate treatment planning and prevention of endodontic failure.

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FOOTNOTES

All authors have no conflict of interest to declare in this article.

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