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Mandibular second molar fusion with a mandibular third molar: A clinical and radiographic diagnostic challenge

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Summary

Dental developmental anomalies comprise a heterogeneous group of conditions manifesting as alterations in the number, size, shape, and structure of teeth. Among these, dental fusion the developmental union of two or more separately developing tooth germs presents a significant clinical challenge because of its rarity in the permanent posterior dentition. This report presents a rare instance of unilateral fusion between a mandibular second molar and a mandibular third molar in a 37-year-old Chinese male. The patient presented for a routine checkup, where clinical examination identified a "double crown" morphology with seven distinct cusps. Radiographic evaluation, initially via panoramic and periapical views and subsequently through cone-beam computed tomography, confirmed the diagnosis of fusion. The imaging revealed a complex internal architecture characterized by three parallel roots and a shared pulp chamber communicating with three separate root canals. A confluence of dentin and a vertical radiopaque line within the crown were pathognomonic features distinguishing this anomaly from gemination and concrescence. This case is particularly notable given the history of extractions of third molars in all other quadrants, reinforcing the diagnosis of true fusion of the second and third molar anlagen rather than union with a supernumerary tooth. The report discusses the multifactorial aetiology of fusion, the application of Mader's "two-teeth" rule, and the importance of advanced three-dimensional imaging in guiding management. Long-term prognosis for such teeth depends on rigorous hygiene to mitigate risks of caries and periodontal disease associated with irregular morphology.

Keywords: *Tooth Abnormalities, Fused Teeth, Cone-Beam Computed Tomography, Molar*

Introduction

The morphogenesis of the human dentition is a highly regulated biological process involving reciprocal interactions between the oral epithelium and the underlying mesenchyme.[1] Disruptions during the various stages of odontogenesis specifically the initiation, morphodifferentiation, and histodifferentiation phases can result in a wide spectrum of dental developmental anomalies.[1–2] These anomalies are often classified based on their manifestation in tooth position, number, shape, and structure.[1] Among shape-related abnormalities, the category

of "double teeth" or twinning anomalies, which includes fusion, gemination, and concrescence, is of particular interest to the clinical community due to the diagnostic complexities they present.[2-5]

Dental fusion is defined as the union of two or more normally distinct tooth germs, leading to the formation of a single enlarged tooth.[1] This developmental union occurs through the confluence of dentin and, in most cases, enamel, during the stage of tooth formation.[5] The degree of union is primarily dictated by the developmental stage at which the tooth germs come into contact.[1–2] Fusion occurring at an early stage, prior to the calcification of the dental hard tissues, typically results in a complete union of the enamel, dentin, and pulp systems.[5-7] Conversely, if the contact occurs at a later stage of morphodifferentiation, the union may be limited to the dentin or cementum, often resulting in separate root canals or pulp chambers.[7-10]

The prevalence of dental fusion exhibits a marked disparity between the primary and permanent dentitions. In the primary dentition, the incidence is relatively common, with reported rates ranging from 0.5% to 2.5%.[2] In contrast, the occurrence in the permanent dentition is significantly lower, estimated at approximately 0.1% to 0.47% across various global populations.[2-3] Furthermore, fusion demonstrates a strong predilection for the anterior region of the dental arch, frequently involving the maxillary and mandibular incisors and canines.[1–2] The manifestation of this anomaly in the posterior mandibular region, particularly involving the second and third molars, is exceedingly rare and often poorly documented in the dental literature.[2]

The etiology of dental fusion remains a subject of ongoing research, though it is generally accepted to be multifactorial.[1] One prevalent theory posits that mechanical forces or excessive physical pressure exerted on the developing tooth germs causes them to be pushed together during development.[1-3] This localized pressure may lead to the necrosis of the intervening follicular tissue, allowing the separate dental papillae and enamel organs to fuse.[4] Genetic factors also play a critical role, as evidenced by familial occurrences of dental twinning and the identification of candidate gene variants.[2-3] Research focusing on Chinese and Mongoloid populations has highlighted specific genetic markers, such as ERCC6 and SLC27A3, which may contribute to a higher frequency of fusion anomalies in these groups.[11] Environmental factors, including trauma to the deciduous precursors, nutritional deficiencies, and maternal exposure to certain medications during pregnancy, have also been suggested as potential cofactors.[1]

Clinically, fused teeth present unique challenges for the practitioner. The resulting tooth structure is typically characterized by macrodontia, featuring an abnormally wide mesiodistal crown diameter and a complex occlusal morphology.[5] Deep fissures and grooves at the site of the union are common, predisposing the area to bacterial biofilm accumulation and subsequent dental caries and periodontal disease.[7] Furthermore, the unusual crown dimensions can lead to arch length discrepancies, crowding, malocclusion, and aesthetic concerns, particularly when the anterior teeth are affected.[2-3] The internal anatomy of fused teeth is equally complex, often presenting with interconnected pulp chambers and unpredictable root canal configurations that complicate endodontic management.[7-10, 12]

The purpose of this case report is to describe a rare instance of a 37-year-old Chinese male with a fused mandibular second and third molar. This report highlights the diagnostic process, utilizing Mader's "two-teeth" rule and advanced three-dimensional imaging, and provides a comparative analysis of this case against documented instances of molar fusion in the contemporary literature.[8] Such detailed documentation is essential for refining diagnostic criteria and developing tailored management strategies for these complex dental anomalies.

Case presentation

A 37-year-old Chinese male patient presented to the MMMC Dental Clinic for a routine dental

checkup and professional scaling. The patient's chief complaint was non-specific, as he was asymptomatic and sought only a periodic evaluation of his oral health. Upon clinical examination, a morphologically atypical molar was identified in the left mandibular posterior region, occupying the anatomical area typically reserved for the second and third molars.

Clinical History and Evaluation

The patient's medical history was generally unremarkable and non-contributory to the dental findings. At the time of presentation, he was taking Loratadine (10 mg daily) and Mecobalamin (500 mg three times daily) for the management of flu-related symptoms. His family history revealed that his father suffered from hypertension; however, the patient reported no known familial history of dental developmental anomalies or supernumerary teeth. In terms of oral habits, the patient noted a history of mouth breathing during sleep. His dental homecare regimen included brushing once daily and using an interdental brush; he denied the use of dental floss or mouthwash.

Intraoral examination of the left mandibular quadrant revealed an unusually large molar structure in the position of teeth #37 and #38 as seen in Figure 1. The tooth exhibited a significantly increased mesio-distal crown width, resulting in a striking "double crown" appearance. The occlusal morphology was highly complex, featuring a total of seven cusps. The buccal aspect displayed four cusps: a large and prominent mesiobuccal cusp, a middle buccal cusp, a small distobuccal cusp, and a fourth distobuccal cusp positioned at the buccodistal angle. The lingual aspect featured three cusps: a mesiolingual, a middle lingual, and a small, pointed distolingual cusp.

A shallow developmental fissure was observed partially dividing the crown, consistent with the union of two molar germs. The occlusal fissures were deep and well-defined, showing no signs of erosion or active carious lesions. The atypical molar was in functional occlusion with the maxillary left first and second molars. Other notable findings in the quadrant included a distolingually rotated left mandibular second premolar and an existing composite restoration on the left mandibular first molar. Extraoral examination showed no abnormalities, and there was no evidence of lymphadenopathy suggesting the absence of infection or facial asymmetry.

Radiographic Investigation

IOPA and Panoramic radiograph revealed an abnormally large tooth with an unsually wide crown distal to lower left first molar (Figure 2 and Figure 3). The panoramic evaluation provided a critical diagnostic clue: there was a complete absence of third molars in the other three quadrants (upper right, upper left, and lower right). The atypical molar in the lower left quadrant was fully erupted and showed no signs of impaction. The surrounding cancellous bone showed a normal trabecular pattern with no evidence of periapical radiolucency or other pathological changes.

The OPG and IOPA images revealed a unique root morphology. The tooth possessed three distinct, well-defined roots mesial, middle, and distal positioned parallel to one another and separated by normal interradicular bone. All roots showed a slight distal inclination, with the mesial root being the longest and the middle root being the shortest in the sagittal view. A thin, vertical radiopaque line was visible within the crown, extending from the occlusal surface toward the cervical area, which was interpreted as an internal enamel septum. A confluence of dentin was clearly observed, a hallmark of dental fusion. The extent of developmental anomaly and canal configuration in this enormous tooth cannot be ascertained due to superimposition of structures in two-dimensional radiographs. Therefore, patients were referred for cone beam computed tomography (CBCT) scan of the same region.[11] Table 1 illustrates the clinical and radiographic findings of the anomaly and its clinical significance.

Advanced 3D Imaging

CBCT images were acquired using a Planmeca Promax 3D Mid (Planmeca, Helsinki, Finland) with the following parameters: an 80mm field of view at 90kV, 11mA, 12.03 seconds exposure span, voxel size of 200 microns and slice thickness of 0.2mm. The scan was visualised using Romexis software version 6.5.1. Morphology of the tooth was analysed using sagittal, axial, coronal and reconstructed 3D sections (Figure 4, 5, 6 and 7 respectively). All three sections confirmed the presence of fusion of second and third lower left molars. Sagittal section showed a significantly wider crown exhibiting fusion of second and third molar with continuity of both enamel and dentin. They share a common pulp chamber. Three distinct roots are observed in their full length: mesial, central, and distal root. Axial sections at the mid-root level revealed three different roots and each of the three roots possess a single canal which is Vertucci Type I.[13] Coronal section revealed slight curvature of mesial root. This three-dimensional characterization was essential to differentiate the case from gemination, which typically presents with a single root and root canal, and from concrescence, which involves the union of roots by cementum alone.[10] The final diagnosis confirmed a fusion between the mandibular second molar and the third molar.

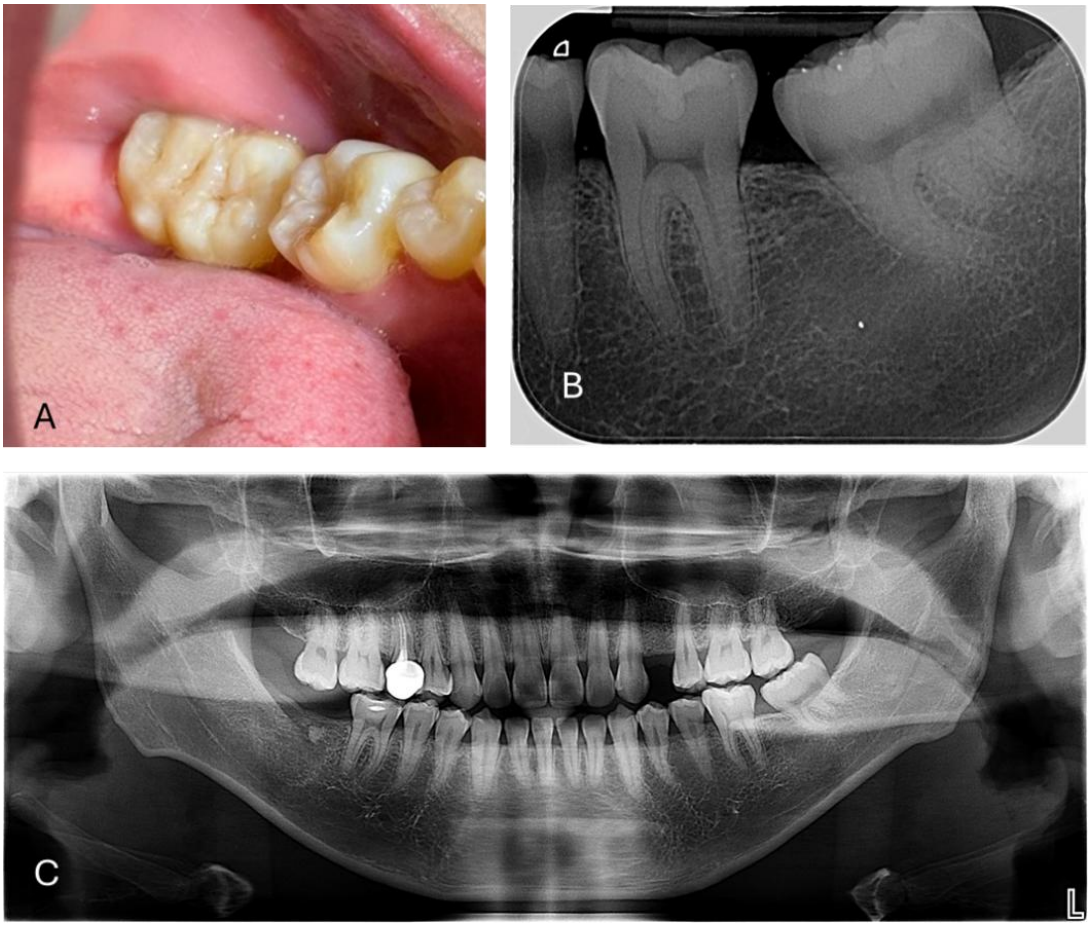

Figure 1.A. Occlusal view of the atypical molar with increased mesiodistal width. B. IOPA showing fusion of 37 and 38 with confluent dentin C. Panoramic radiograph reveals a fused tooth with increased mesio-distal width.

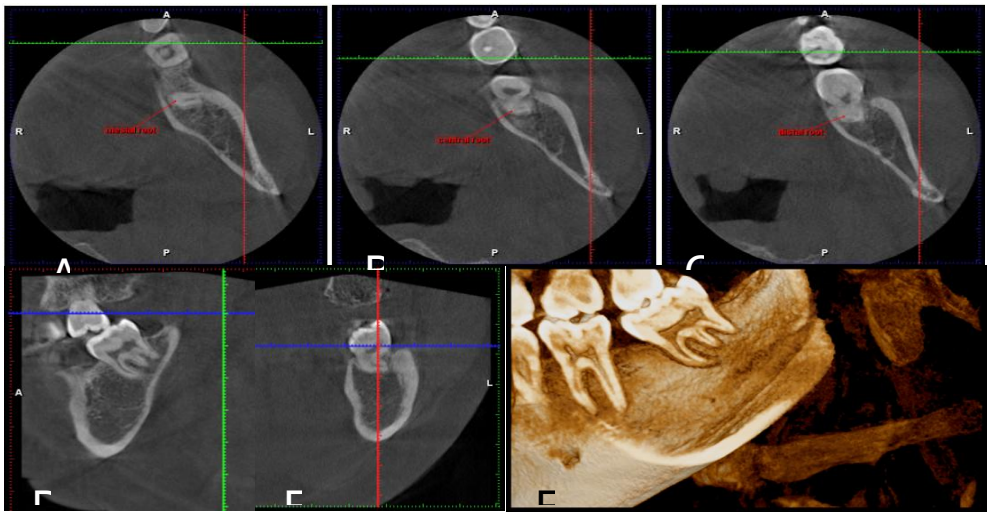

Figure 2. A-C. Axial section showed three distinct roots. D. Sagittal section revealed a fusion of second and third lower left molar. E. Coronal section revealed slight curvature of mesial root. F. Reconstructed panoramic image

Table 1 details the significance of the observed features in the presented case

Radiographic Feature	Observation	Clinical Significance
Third Molar Status	Extracted due to caries in quadrants 1,2 and 4	No evidence of supernumerary tooth was observed in quadrant 3, indicating fusion between tooth 37 and 38 rather than fusion between a normal tooth and a supernumerary tooth.
Root Number	Three distinct roots	Suggests Aguilo Type IV fusion
Dentin Structure	Confluent dentin	Diagnostic for fusion vs. concrescence
Crown Internal	Vertical enamel line	Pathognomonic for true fusion
Pulp Chamber	Single, shared chamber	Indicates union occurred prior to canal separation
Canal System	Three root canals	Complex anatomy for potential endodontics
Relation to the adjacent tooth	Space between the abnormal tooth and 36	Reduced mesiodistal dimension of fused 37 and 38 when compared to the combined mesiodistal dimensions of 37 and 38 respectively, causing the space between 36 and the fused tooth

Table 2 summarizes findings from various clinical reports of molar fusion, illustrating the diversity of anatomical configurations and the importance of identifying the involved germs.

Study	Patient Profile	Tooth Involved	Clinical/Radiographic Findings	Diagnosis
Present Case	37 year old Chinese Male	#37 and #38	7 cusps, 3 roots, shared pulp, 3 canals	2nd/3rd Molar Fusion
Kavadella et al.	69 year old Greek Male[2]	#37 and #38	8 cusps, 3 roots, 2 pulp chambers, 3 canals	Type IV Molar Fusion
Venkatesh et al.	26 year old Female[6]	Mandibular 2nd Molar	Fusion with a paramolar	Molar-Paramolar Fusion
Alshamrani et al.	28 year old Female[4]	Mandibular 3rd Molar	Fusion with a 4th molar/supernumerary	3rd/4th Molar Fusion
Gunduz et al.	24 year old Male[11]	Mandibular 3rd Molar	Union by cementum with 4th molar	Mandibular Concrescence
Mei et al.	21 year old Male[12]	Maxillary 2nd Molar	Fusion with two paramolars, isthmus infection	Molar-Supernumerary Fusion

Discussion

The identification of a fused mandibular second and third molar is a noteworthy clinical finding, as this specific combination is among the rarest documented in the literature of dental anomalies.[2] While molar fusion involving supernumerary teeth (such as paramolars or distomolars) is more frequently reported, the union of two normal successive tooth germs in the permanent posterior mandible represents a significant developmental aberration.[3-5] The clinical presentation in this 37-year-old male highlights the diagnostic hurdles faced by clinicians and the importance of a systematic approach to classification.

Epidemiological Trends and Global Context

Epidemiological studies have consistently shown that the prevalence of fusion in the permanent dentition is low, typically around 0.1%.[1–2] A large-scale radiological study in a Turkish population of over 8,000 subjects found a prevalence of "double teeth" (fusion and gemination combined) of 0.29%, with the anomaly being more frequent in the upper jaw and usually appearing unilaterally.[2-3] In that study, the most commonly affected teeth were the maxillary incisors, followed by mandibular premolars. Another study reported that fusion in the mandibular third molar region occurred in only 0.91% of cases, making it far less common than fusion in the maxillary incisor region (3.55%).[6]

The patient's ethnicity is also a relevant factor in the clinical analysis. High incidence rates of fusion have been observed among Asian and Native American populations.[2] Research focusing on the genetic basis of these anomalies has identified variants such as ERCC6 and SLC27A3 that are more prevalent in Chinese and Mongoloid groups, potentially explaining the occurrence of fusion in this patient.[11] These genetic predispositions, coupled with possible mechanical or environmental triggers during the morphodifferentiation stage of tooth development, lead to the formation of the anomalous "double" structure.[1–2]

Classification and Diagnostic Rules

A critical step in the differential diagnosis of dental twinning anomalies is the application of Mader's "two-teeth" rule (1979).[8-9] This rule states that if the anomalous tooth is counted as one and the number of teeth in the dental arch is reduced, the diagnosis is fusion.[8] If the tooth count remains normal, the anomaly is classified as gemination or the fusion of a normal tooth with a supernumerary tooth.[3-7] In the present case, the patient reported a history of prior extractions, and denied history of extractions in the quadrant, which confirmed a missing tooth from the normal series. This clearly identified the condition as a fusion between the second and third molars.

Furthermore, the morphological presentation can be classified using Aguilo et al.'s framework for fused teeth.[9] This case aligns with Type IV fusion, which is defined by the presence of two fused crowns and two or more "glued" or parallel roots.[2–10] This is distinct from Type I (bifid crown, single root) or Type II (large crown, large root), which are more commonly associated with gemination or anterior fusion.[10] Table 2 summarizes the previously reported cases of posterior teeth fusion from the literature.

Diagnostic Challenges and Differential Diagnosis

The primary diagnostic dilemma in these cases is distinguishing fusion from gemination and concrescence. Gemination results from the attempted division of a single tooth germ, typically resulting in a bifid crown and a single root/canal system.[1–2] While gemination of a second molar might clinically mimic the current case, the radiographic finding of three distinct roots and three canals combined with the reduction in the total molar count effectively rules it out.[8-10] Concrescence, on the other hand, is a condition where two fully developed teeth are joined by cementum only.[10] Unlike the confluent dentin and vertical enamel septum observed in this patient, concrescence usually results in

separate crowns and separate pulp/canal systems.[10]

The radiographic identification of concrescence is particularly difficult because the crowns appear normal and the union is hidden beneath the alveolar bone.[10] It is often an incidental finding during difficult extractions, which can lead to the inadvertent removal of the "mate" tooth or fractures of the alveolar bone.[10] In contrast, the current case was identified through routine clinical examination due to the striking macrodontia and "double crown" morphology, which is characteristic of fusion occurring at an earlier developmental stage.[2]

Importance of Volumetric Imaging (CBCT)

The advancement of imaging technology has fundamentally changed the management of dental anomalies. Standard two-dimensional radiographs, such as IOPA and OPG, are often insufficient for complex cases due to the superimposition of anatomical structures.[12] In this case, while initial radiographs suggested the anomaly, the definitive understanding of the internal morphology was only possible through CBCT.[12] CBCT allows for a detailed analysis of the pulp chamber continuity and the precise number and path of the root canals in three planes.[7-11]

The American Association of Endodontists and the American Academy of Oral and Maxillofacial Radiology recommend CBCT as the imaging modality of choice for teeth with potential complex morphology.[7-10, 12] For fused molars, CBCT facilitates accurate endodontic treatment planning by identifying whether pulp chambers communicate and whether there are isthmuses or C-shaped variations.[7-10, 12] In the Ecuadorian population, for instance, C-shaped canals were found in 28% of mandibular second molars, and identifying such variations is critical to avoid iatrogenic errors during debridement and obturation.[4] In the current case, CBCT provided the clinician with the security of knowing that any future endodontic intervention would involve three distinct canals originating from a shared chamber.

Management Considerations and Future Outlook

Clinical management strategies for fused teeth vary depending on the patient's symptoms, the aesthetic impact, and the potential for functional compromise. [2]

1. Conservative Monitoring: For the asymptomatic patient described in this report, the most prudent approach is regular follow-up and rigorous preventive care.[12] The use of fissure sealants and topical fluorides can help manage the high risk of caries in the deep occlusal grooves.[7]
2. Endodontic and Restorative Treatment: If pulpal pathosis develops, nonsurgical endodontic therapy is often the first line of defense.[7-10, 12] Modern techniques, including the use of dental operating microscopes and thermoplasticized gutta-percha, have improved the success rates of treating these complex canal systems.[7-10,12] Successful management of molar-paramolar fusion with pulp necrosis has been documented, highlighting that these teeth can be retained if treated with precision.[7]
3. Surgical Intervention (Bicuspidization/ Extraction): In cases where the fusion interferes with orthodontic alignment or causes severe periodontal issues, surgical separation (bicuspidization) or extraction may be necessary.[10] Reports show that bicuspidization of fused premolars can yield stable outcomes over a 9-year follow-up period. However, extraction remains the most common treatment for fused third molars due to their location and the invasive nature of other therapies.[10]
4. Orthodontic Considerations: The increased mesiodistal width of fused teeth can lead to midline deviations and crowding. Management may involve the stripping of the anomalous tooth or orthodontic movement of the fused unit, although such movements

across anatomical boundaries like the midpalatal suture are complex.[5]

The future of managing such cases may also involve adjunctive decision-support systems. Preliminary research has evaluated the role of generative AI in providing differential diagnoses and management strategies for oral and maxillofacial radiology, suggesting that these tools may one day assist board-certified radiologists in identifying rare anomalies from CBCT data.[2]

Conclusion

The presented case of mandibular second and third molar fusion represents a rare but significant dental developmental anomaly. Through the integration of clinical assessment, adherence to Mader's "two-teeth" rule, and high-resolution three-dimensional imaging, a definitive diagnosis was achieved, distinguishing the condition from gemination and concrescence.[8] This case underscores the inherent variability in posterior dental development and highlights the critical role of advanced imaging in delineating internal anatomy. The identification of confluent dentin and a shared pulp chamber through CBCT was essential for guiding potential future therapeutic interventions. Clinicians must remain vigilant for unusual molar morphologies, as early identification allows for the implementation of preventive strategies to manage the associated risks of dental caries and periodontal disease. This documentation contributes to the growing body of knowledge on rare dental anomalies, emphasizing the necessity of a multidisciplinary diagnostic approach in contemporary dental practice.

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