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Gemination and Fusion
A Literature Review

A project submitted to college of Dentistry, University of Baghdad/
Department of oral diagnosis in partial fulfillment of the requirements
for B.D.S degree

By

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

وَعَلَّمَكَ مَا لَمْ تَكُن

تَعْلَمُ

صدق الله العلي العظيم

(سورة النساء الآية 113)

Certification Of Supervisor

I certify that this project entitled *Gemination Teeth* was prepared by the fifth-year student **Dhafar Saadi Khalbas** under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

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Introduction

Gemination and twinning are uncommon developmental anomalies of the hard dental tissue. These aberrations are manifested either as anomalous teeth or as supernumerary teeth.

The form of primary and permanent teeth can differ morphologically from that which is considered normal, completely or in some parts. The changes in tooth form can be hereditary or caused by some disease or trauma.

Gemination means that two separate morphological units were created by division of the tooth germ.

Geminated teeth are the consequences of developmental anomalies leading to the eruption of joined elements. According to current definitions, gemination occurs when one tooth bud tries to divide.

CHAPTER ONE
REVIEW OF LITERATURE

1.1 Gemination

Gemination and twinning are two rarely encountered developmental abnormalities. Although the precise etiology remains. Genetic predisposition is often suggested in the process (**Krishnamurthy *et al.*, 2018**).

Gemination is an anomaly caused by a single tooth germ that attempted to divide during its development, resulting in a bifid crown **figure(1-1)**. They are found more frequently in the primary than in the permanent dentition unilaterally. bilateral gemination is very rare. It is caused by complex interactions among a variety of genetic and environmental factors.

This developmental anomaly may cause clinical problems including esthetic impairment, periodontal problems, caries, and tooth crowding (**Soxman *et al.*, 2019; Ben Salem *et al.*, 2021; Rao *et al.*, 2013**). The main periodontal complication in gemination cases occurs due to the presence of fissures or grooves in the union between the teeth involved. If these defects are very deep and extend subgingivally, the possibility of bacterial plaque accumulation in this area is quite high. Strict oral hygiene is imperative to maintain periodontal health. Furthermore, gemination may have an adverse effect on occlusion, causing deviation. (**Neena *et al.*, 2015**).



Figure (1-1): Gemination of teeth is a dental condition in which one tooth bud has produced two twin teeth. They are bonded together and separated by a cleft in the middle of the crown. **(Wilson, 2014).**

Severity of gemination is based on the phase of formation of the tooth affected. The incidence of this type of developmental anomalies was reported to be less than 1%. Appropriate diagnosis in early stages can prevent future problems and postsurgical complications, and can also facilitate the clinical management of such cases **(Khawaji et al, 2020)**. This condition has a familial tendency . It may be associated with syndromes such as achondrodysplasia, and chondroectodermal dysplasia, or can be found in nonsyndromic patients. Gemination is seen more in the primary dentition than permanent dentition and this has an effect on the succedaneous dentition such as delayed exfoliation of the affected teeth due to greater root mass and increased root surface area. **(Neena et al, 2015)**.

1.2 The prevalence of gemination

Gemination are not entirely uncommon dental anomalies that may also be named 'double teeth'. This is due to their unusual presentation in a twin-like fashion Teeth with these irregularities may appear clinically similar, presenting as large and bulbous in shape with unusual anatomy and fissure patterns (**Masood and Benavides, 2018; Pandya-Sharpe and Puryer, 2021**).

The prevalence of gemination or fusion is 2.5% in primary dentition, and 0.1 - 0.2% in permanent dentition. It is more frequently observed in primary than permanent dentition; anterior than posterior teeth; unilaterally than bilaterally. Unilateral gemination has a prevalence rate of 0.5% and 0.1% in deciduous and permanent dentition, respectively. Bilateral cases are seen in 0.01% to 0.04% in primary dentition and in 0.02% to 0.05% in permanent dentition.(**Mahendra et al, 2014**). It commonly occurs in the primary upper incisors. Gemination is more commonly seen the in maxillary whilst fusion is more commonly seen in the mandibular arch (**Nandini et al., 2021**).

1.3 Signs and symptoms

- Misaligned teeth can lead to chewing difficulty and damage adjacent structures (**Zou et al., 2018**).
- Occlusion affected, causing deviation (**Fekonja, 2017**).
- Asymmetry of the dental arch due to enlarged crown (**Masood and Benavides, 2018**).
- Aesthetic problem.
- Delay or obstruct the eruption of adjacent tooth.

- Tooth anatomy making the surface hard to clean and increase susceptibility of dental decay and periodontal disease (**Nandini et al., 2021**).

1.4 Causes

The cause of gemination is still unknown. However, They arise due to some unknown disturbance that occurs in a developing tooth germ as it passes through stages of histodifferentiation and morphodifferentiation. (**Rajeswari et al., 2011**).

There are a few possible factors contributing to gemination:

- Vitamin deficiency
- Hormonal irregularities (**Masood and Benavides, 2018**).
- Infection or inflammation of areas near to the developing tooth bud
- Drug induced
- Genetic predisposition
- Radiotherapy that caused damage to the developing tooth germ (**Folayan, 2019**).
- Various theories have been put forward to explain the aetiology of fusion including that of increased force generated during growth, use of thalidomide or viral infection during pregnancy and a genetic aetiology . which may also result in fusion (**Kamath et al., 2018**). Theree are thought to be more than 300 genes responsible for odontogenesis A defect in any of these genes may result in altered morphology of a tooth, and disturbances affecting these genes may occur pre- or postnatally. Consequently, either dentition may be affected (**Masood and Benavides, 2018; Tritsaroli, 2018**).

1.5 Teeth fusion and tooth gemination

Fusion can be described as the complete or partial union between the dentin and enamel of two or more developing teeth. This union could be seen in the primary or permanent dentition or between a permanent tooth and a supernumerary tooth. **(Kamath et al., 2018)**. Gemination is very often confused with fusion (two teeth unite to become one) **Figure (1-2)** .But may be differentiated based on the fact that the number of teeth in fusion is less than the actual number of teeth that should be present in the mouth **(Pandya-Sharpe and Puryer, 2021)**. The main difference lies in the fact that a tooth with gemination will have a single root and canal whereas in fused teeth, there will be independent roots and canals **figure(1_3) (sammartino et al., 2014)**

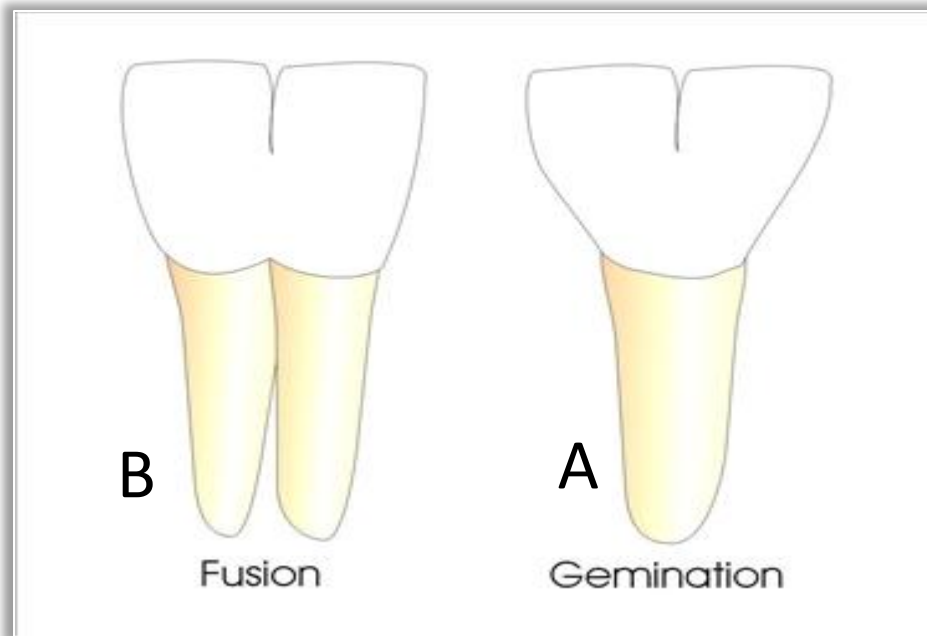


Figure (1-2):Examples of (A) gemination; (B) fusion
(Ramezani *et al.*, 2021).



Figure (1-3): Following horizontal sectioning it is evident that even the dentine is fused and that there is a communication between the two pulp systems (Kremeier *et al.*, 2007).

1.6 Clinical presentation

Abnormalities within the human dentition may present in various forms. These include irregularities in the number, size, shape, or structure of teeth, and occur as a result of disturbances during odontogenesis. Tooth gemination presents as two completely or partially separated crowns stemming from a single shared root **Figure (1-4)**. occurs as result of the division of a single tooth bud (**Oliveira *et al.*, 2019**)



Figure (1-4): Diagrammatic representation of geminated teeth with a bifid crown and shared roots and root canal systems: (a) geminated molar tooth; (b) geminated incisor (**Pandya-Sharpe and Puryer, 2021**).

The irregular structure of these teeth can cause them to be the subject of higher caries and periodontal risks, whilst also posing occlusal, functional, and aesthetic difficulties for patients especially when anterior teeth are affected **Figure(1-5)** (**Pandya-Sharpe and Puryer, 2021**).



Figure(1-5) : (a)Intraoral photographs. Carious large crown of tooth primary upper left central incisor associated with dental caries of upper left lateral incisor (Ben Salem et al., 2021).

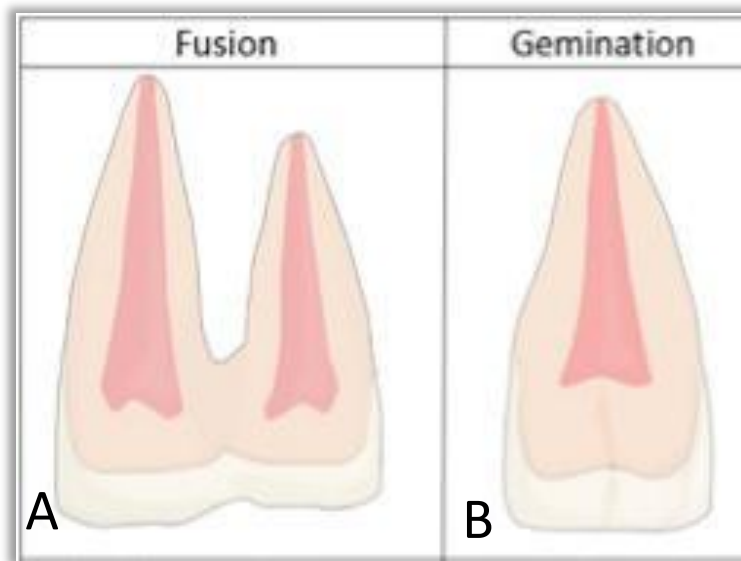


Figure (1-5) : (b) Occlusal photograph showing the anterior teeth nonalignment and distal rotation of tooth primary upper right central (Ben Salem et al., 2021).

When affecting the primary dentition, eruptive disturbance of successional teeth can also be problematic (Mahendra *et al.*, 2014). As a result, both fused and geminated teeth can present numerous restorative challenges to the dentist. This can include complex endodontic work, difficulty in recreating intricate and unusual anatomy for direct restorations, difficulty in achieving an aesthetic (Alyahya *et al.*, 2021) result acceptable to the patient and hardship in achieving adequate periodontal hygiene for the patient. A multidisciplinary approach may be required for especially complex cases (Halai and Bhakta, 2021).

1.7 Differential Diagnosis:

The clinical differentiation between fusion and gemination can be difficult, but as fusion refers to the joining of two individual tooth buds, in the exception that one tooth bud was that of a supernumerary tooth, the patient would present with one tooth fewer than the normal Figure(1-6) and figure (1-7) (Sandeep *et al.*, 2020).



Figure(1-6) : (a) Fusion of cementum, dentine and enamel. One less tooth in the arch. (b) Single large shared pulp canal and a bifid crown. Normal of teeth in the arch (Halai and Bhakta, 2021).

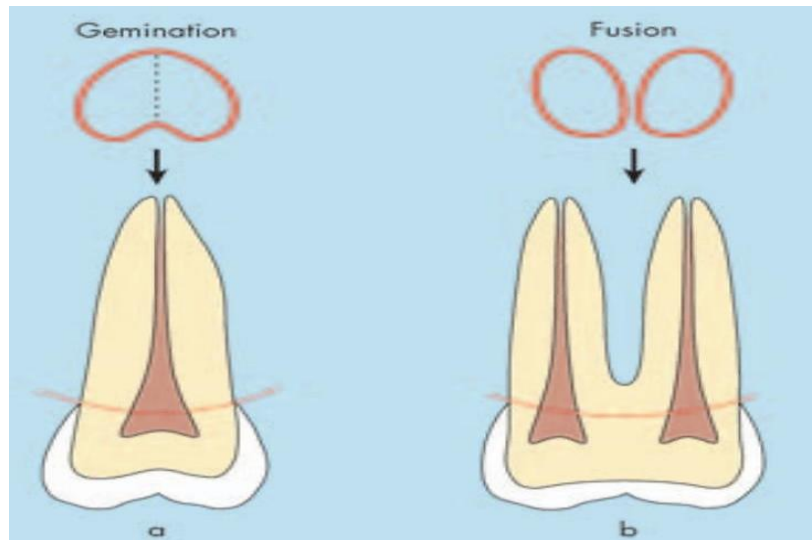


Figure (1-7) : Schematic drawing of different types of double teeth **(a):** Gemination Attempted division of single tooth germ, resulting in one structure with complete incompletely separated crowns with a single root and root canal.

(B): Fusion . Union of 2 normally separate teeth (central incisor and later incisor for example) May be the result of pressure and crowding during tooth development (**Kremeier et al., 2007**).

Therefore, this may be noticed during a routine dental charting (**figure 1-8**). As gemination is the division of one tooth bud, tooth count is regular and so may just be observed through the presence of a macrodont tooth (**Nandini et al., 2021**). Radiographic analysis is used to confirm the diagnosis by assessing the number of roots as well as the outline of the pulp chamber and pulp horns (**Alkadi et al., 2021**).

As this type of anomaly is one that affects the 3D structure of a tooth, the use of cone beam computed tomography (CBCT) **figure (1_9)** would be the most thorough method of assessing this anomaly for a more accurate differentiation between the two conditions. (**Ramezani et al., 2021**).



Figure (1-8) : (a) Fused left primary molars in the mandibular arch. (Calvo al., 2014).



Figure (1-8) : (b) Occlusal view of the mandibular arch. Fused lower left primary molars (Calvo al., 2014).

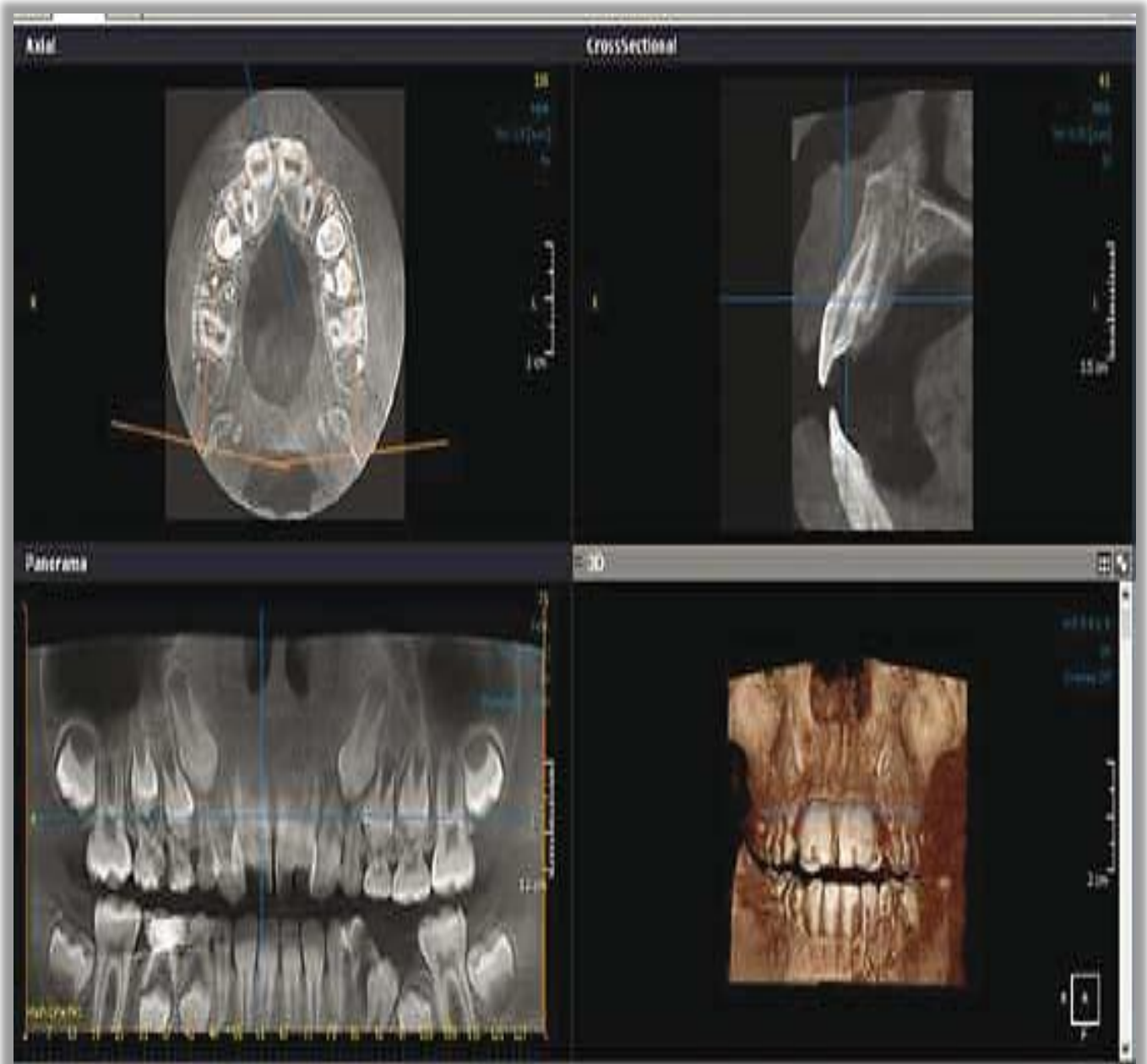


Figure (1-9): CBCT shows geminated central incisors in panorama, cross sectional, axial, and 3D views (Shokri et al., 2013).

1.8 Complication of geminated teeth

Existing literature shows the majority of teeth affected by fusion or gemination to be that of the deciduous dentition, and most commonly, it is the anterior teeth that are affected **figure (1_10)** .Aesthetic problems are therefore the primary complaint in such presentations (**Nandini et al., 2018**).

The irregular morphology of the crown, particularly the presence of a large occlusal table with additional fissures, as well as lingual and labial vertical grooves where the two crowns demarcate, create plaque traps that may be difficult to clean . As well as this, the abnormal shape of the tooth creates oddities in the way the maxillary and mandibular teeth occlude and can cause asymmetry, which interferes with tooth alignment and may result in crowding . These features increase the likelihood of caries (**Costa et al., 2020**).



Figure (1-10) : view of bilateral geminated permanent maxillary central incisors with deep notches.(**Shokri et al., 2013**).

Often, the unusual contour of these teeth, as well as the extension of the vertical grooves subgingivally, can cause food and plaque accumulation at the level of, and beneath, the gingivae, leading to gingival inflammation and pocket formation. Periodontal health may therefore be at risk. In cases where there is crowding of unusually large incisors, accessibility for a patient's oral hygiene becomes difficult and can lead to further deposits and gingival inflammation **figure (1-11) (Venkatesh et al., 2016).**



Figure (1-11) : Permanent mandibular central incisor with a symmetric division of crown caused by incomplete bifurcation on incisal zone. Due to large size of crown, it is observe dental rotation and crowding. In addition, the gingival anatomy is altered. **(victor et al., 2012).**

There is strong evidence of the link between periodontal disease and systemic disease and the importance of maintaining excellent periodontal health is especially relevant for patients at risk of cardiovascular disease or diabetes **(Genco and Sanz, 2020)**. It can occasionally be difficult to identify double teeth on conventional

radiographs due to superimposition .This can create further complications if extracting an undiagnosed fused or geminated posterior tooth in the maxillary arch. This is due to the higher likelihood of fracture of the maxillary tuberosity in consequence to excessive force application when attempting to remove the large tooth (**Niekrash and T Goupil,2019**). This is relevant to the general dental practitioner (GDP), who should promptly refer such a case to an oral surgeon should tuberosity fracture occur.

1.9 Treatment of geminated teeth

This differentiation between gemination and fusion becomes significant in managing instances that require complex treatment. CBCT may be used to assess the potentially intricate root canal system of a double tooth, which will vary greatly between fused and geminated teeth (**Sinnott et al, 2020**). This will allow a specialist to know how to appropriately instrument through the tooth in the event of endodontic pathology or elective endodontic treatment that may occur as a result of pulp exposure during surgical sectioning of a bifid crown (**Zajac et al., 2020**). Further to this, specialists will require detail of the structure of the tooth and therefore whether the tooth has been fused or geminated prior to treatment that may include hemi-sectioning, grinding or surgical extraction. (**Finkelstein et al., 2014**).

Primary aims when treating and gemination cases should be to :

- reduce caries risk
- periodontal risk
- improve aesthetics
- maintain function.

Treatment options will be case dependent and vary greatly due to the multitude of ways in which the tooth may present (Dwivedi, 2018). A multidisciplinary approach with input from orthodontists, prosthodontists and endodontists .

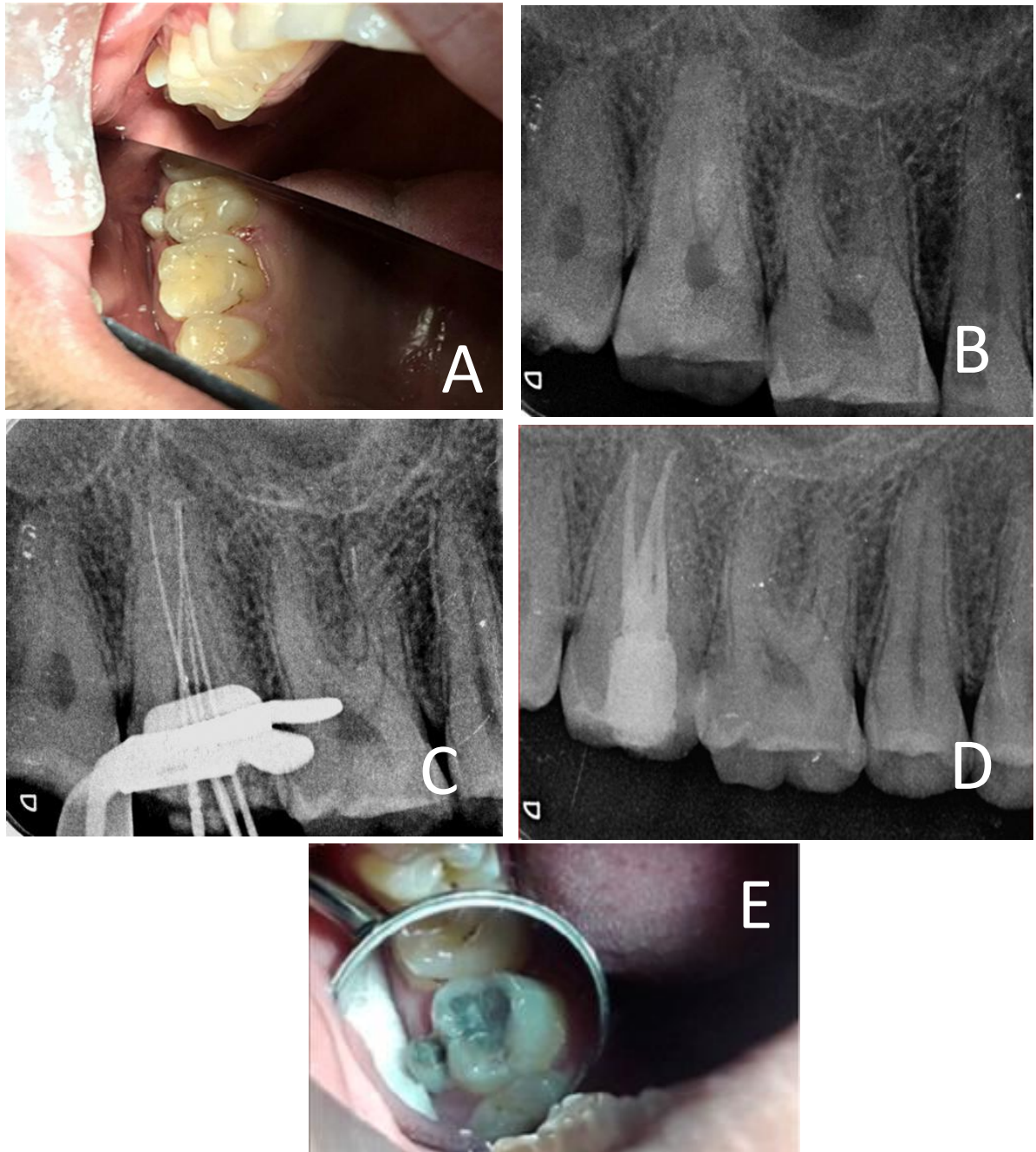


Figure (1-12) : endodontic treatment of of the geminated maxillary second molar tooth using CBCT (A) Intraoral photograph of the tooth

(B) Preoperative radiograph of the right maxillary second molar

- (C) Radiograph to determine the working length
- (D) Post-obturation radiograph
- (E) Intraoral photograph at the 3-month follow-up (**Ramezani et al., 2021**).

oral surgeons may be required (**Piai Pereira et al., 2019**). with treatment decision taking factors including the location of the tooth, the patient's age, the degree of involvement and the stage of root development into consideration .

(**Pandya-Sharpe and Puryer, 2021**). Possible treatment options include endodontic treatment proceeded by 'slicing' or hemi-sectioning of the tooth and direct restoration with composite resin This may be followed by orthodontic alignment (**Finkelstein et al., 2014**). **figure (1-13)** especially for anterior cases where significant spacing may result following hemi-sectioning of the tooth.

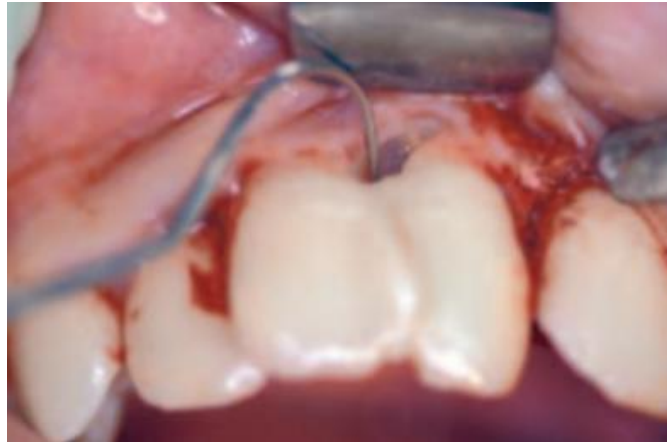
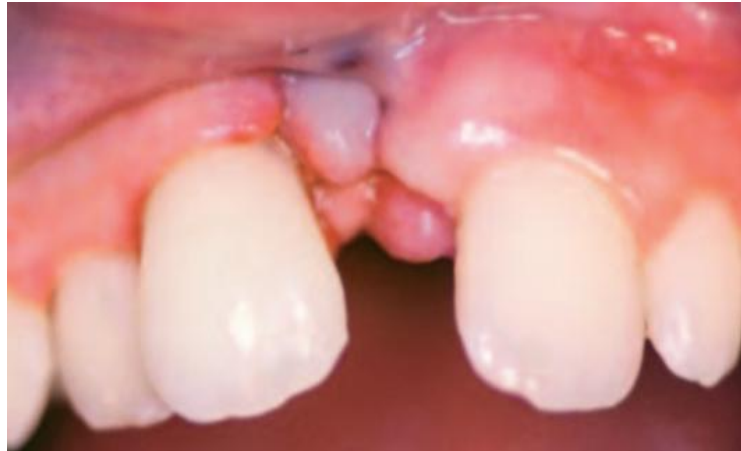


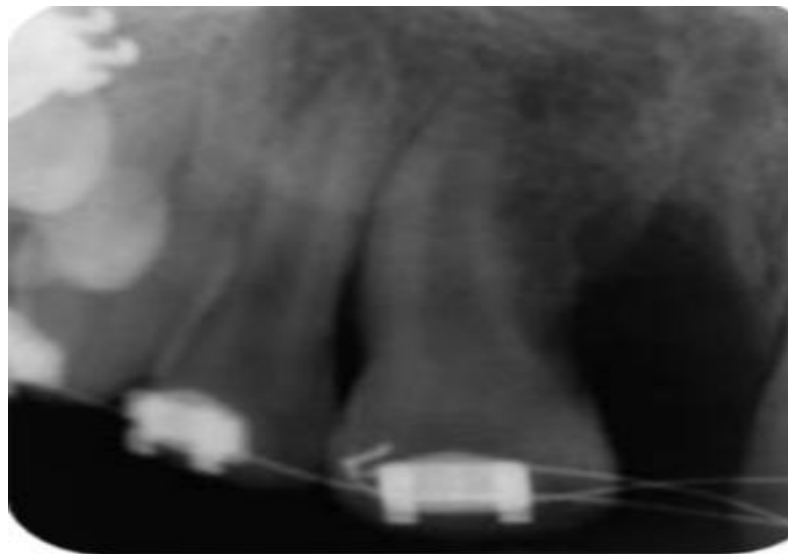
Figure (1-13) : (a) Peri-operative view: the separation between the roots could be probed only after osteotomy of the bone.



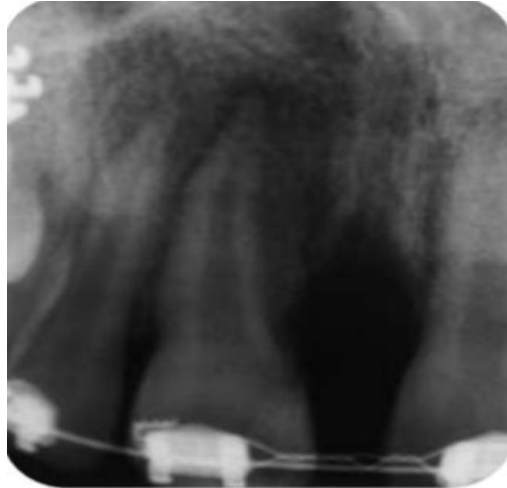
(B) Peri-operative view following separation of the crowns.



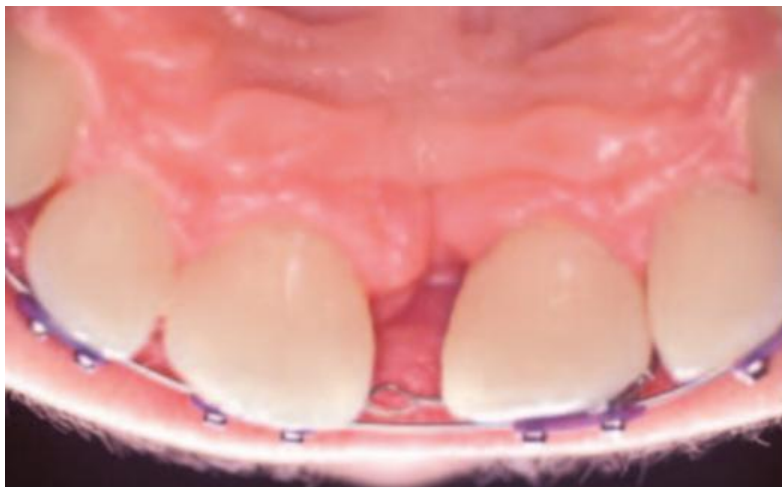
(C): Peri-operative view following suturing. Still no restorative treatment has been performed. The enamel pearls have been smoothed.



(D) :Post-operative radiograph.



(E): Review radiograph three months post-operatively following placement of the orthodontic appliance.



(F) Review 6 months later: the tooth has been restored, orthodontic treatment already has resulted in narrowing of the diastema between the central incisors. ((Kremeier et al., 2007).

In some cases, the tooth may be extracted prior to sectioning and then re-implanted (**AIDhelai, 2021**). However, this may result in ankylosis due to a lack of periodontal membrane where the tooth has been sectioned (**Arhakis et al., 2022**).

Other cases may simply include reducing the size of the double tooth by selective grinding and complete extraction of the tooth (**Thiyezen, 2021**). followed by replacement with either a fixed or removable prosthesis or crowning the tooth (**Hashim et al., 2020**).

When deciduous teeth are affected, treatment options can depend upon the presence of the successor tooth (**Ben Salem et al., 2021**). In some cases, the deciduous tooth may be unrestorable and may simply be left to exfoliate naturally, or it may need to be extracted, depending on the degree of root resorption **Figure (1-14)** (**Tafti and Jawdekar, 2021**).



Figure (1-14) : Extracted fused deciduous maxillary incisor ((**Kremeier et al., 2007**).

As with all patients, consideration must be given to any risks and possible complications that may arise because of treatment. These may include tooth devitalisation (**Nirmala et al., 2015**). in cases that are not endodontically treated Ankylosis (**Halai and Bhakta, 2021**).

Not all patients will require specialist-level care, but GDPs should be aware of the presentation of these teeth so that an early diagnosis can be made, and preventative care implemented GDPs may seal the fissures and grooves on bifid crowns, improve the aesthetics of affected anterior teeth with direct composite resin restorations promote the importance of immaculate oral hygiene to prevent periodontal disease, encourage good dietary habits and provide fluoride advice(**Miri et al, 2014**) **Figure (1-15)**.



Figure (1-15) :Placement of sealants in the groove of the fused tooth (primary left lower lateral incisor) and restoration of (primary left lower canine) (**Ben Salem et al., 2021**).

Early referral of children to a joint paediatric and orthodontic clinic may also be helpful to allow treatment plans and considerations to begin (**Marra et al., 2020**). These implementations may all serve to reduce the clinical necessity of complex treatment.

CHAPTER TWO

CONCLUSION

Conclusion

Gemination and fusion are rare occurrences that have the potential to have clinically significant implications for a patient. Although many of these teeth may be asymptomatic, early recognition of their presence and unusual anatomy by general dentists can be important to prevent complications that may require patients to have extensive treatment.

Double teeth in the primary dentition may delay the eruption of permanent teeth, and so GPs should seek specialist advice and carefully monitor these potentially problematic teeth.

Successful treatment of patients with fused and geminated teeth should be focused on prevention, improving aesthetics and maintaining function.

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