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Dental Ankylosis: Prevalence, Etiology and Guidelines for Clinical Management (A Literature Review)

A Project Submitted to
The College of Dentistry, University of Baghdad, Department of Oral Diagnosis in Partial Fulfillment for the Bachelor of Dental Surgery

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Certification of the Supervisor

I certify that this project entitled **"Dental Ankylosis: Prevalence, Etiology and Guidelines for Clinical Management (A Literature Review)"** was prepared by fifth year student **Bashar Salim Abdullah** under my supervision at the College of Dentistry/University of Baghdad in partial fulfillment of the graduation requirements for the bachelor degree in dentistry.

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Dedication

To my dear parents, sisters, brothers and friends for their support and encouragement.

Bashar

Acknowledgment

Primarily I would like to thank the supreme power the **Almighty God** for being able to complete this project with success.

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List of abbreviations

Abbreviation	Phrase
DA	Dental Ankylosis
IO	Infra-Occlusion
PDL	Periodontal Ligament
3D	Three Dimensional
CT	Computed Tomography
CBCT	Cone-beam Computed Tomography
PMC	Preformed Metal Crown
MM	Millimeter

Introduction

Dental ankylosis (DA) is a serious condition defined as the process that causes the fusion between the dentin or the cementum of the root and the alveolar bone, with the obliteration of the *periodontal ligament* (PDL) becoming progressively replaced by bone tissue **(Alruwaithi *et al*., 2017).**

This prevents the normal eruption process and the vertical growth of the ankylosed tooth's bone, while the adjacent teeth continue their eruption process and normal alveolar growth. This situation leads to the altered tooth staying below the occlusal plane, a condition known as *infra-occlusion* (IO) **(Cardozo and Hernández, 2021).**

The first deciduous lower molars are most commonly affected, although ankylosis is also a common complication in cases of reimplanted permanent teeth. Trauma and genetic predisposition are the most etiological factors, these factors will interfere with the balance between the root and alveolar bone, leading to ankylosis and root resorption **(Rosa *et al*., 2019).**

Gault (2013) classified DA according to etiology to post-traumatic ankylosis and idiopathic ankylosis with resorption. The first occurs after trauma to the PDL that is sufficiently severe and of a sufficient extent to prevent periodontal regeneration. The etiology of idiopathic ankylosis with resorption is still unclear. Another classification was based according to the severity of the DA and IO which is mild, moderate and sever **(Eşian *et al*., 2022).**

The diagnosis of ankylosis must be made clinically and radiographically. It should be noted that radiographic evaluation is one of the most important diagnostic methods in patients with ankylosed teeth, the main signs of this anomaly can be observed in radiograph, such as loss of PDL spaceor absence of continuity in the area where ankylosis has occurred **(Dias *et al*., 2012; Cardozo and Hernández, 2021).**

Three treatment approaches (observation, extraction and restoration to occlusion) utilized by the attending dentists. Usually slight and moderate ankylosis will self-resolve; intervention is needed for the severe ankylosis cases **(Kennedy, 2009).**

Aims of the study

1. To know the definition of dental ankylosis.
2. To see how mush dental ankylosis is prevalent among the world population.
3. To understand the causes and the mechanism of formation of dental ankylosis.
4. To be familiar with the management and treatment of dental ankylosis.

Chapter one: Review of literature

1.1 Eruption of teeth

Eruption is the axial movement of a tooth from its nonfunctional position in the bone to functional occlusion. However, eruption is often used to indicate the moment of emergence of the tooth into the oral cavity. The normal eruption of deciduous and permanent teeth into the oral cavity occurs over a broad chronologic age range. Racial, ethnic, sexual, and individual factors can influence the eruption and are usually considered in determining the standards of normal eruption **(Suri *et al*., 2004).**

For teeth to become functional, considerable movement is required to bring them into the occlusal plane. The movements teeth make are complex and may be described in general terms known as eruption phases **(fig. 1.1) (Nagata *et al*., 2019): pre-eruptive tooth movement**: made by the deciduous and permanent tooth germs within tissues of the jaw before they begin to erupt. **Eruptive tooth movement:** made by a tooth to move from its position within the bone of the jaw to its functional position in occlusion (This phase is subdivided into intra- and supra-osseous phases.). **Post-eruptive tooth movement:** maintaining the position of the erupted tooth in occlusion while the jaws continue to grow and compensate for occlusal and proximal tooth wear **(Nanci, 2018).**

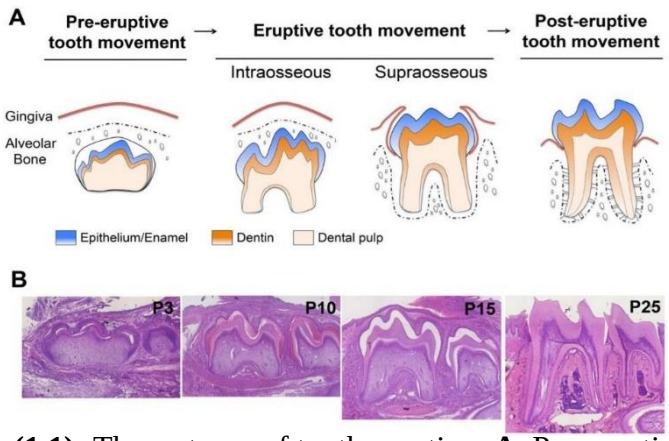

Figure (1.1): Three stages of tooth eruption. **A.** Pre-eruptive tooth movement,Eruptive tooth movement and post-eruptive tooth movement. **B.** Histologic sections of molars at different time points during tooth root formation in mice **(Nagata *et al*., 2019).**

Normal biologic eruption time is defined as tooth eruption that occurs when the dental root is approximately 2/3 its final length. **Delayed biologic eruption** is defined as tooth eruption that has not occurred despite the formation of 2/3 or more of the dental root. Thus, if a patient has chronologic delayed eruption, he or she might simply be of a dental age that does not fit the standards (root length less than 2/3) **(Suri *et al*., 2004).**

The speed and timing of eruption is critical for proper tooth positioning. Delays in the eruption process can result in ankylosis and failure of eruption **(Hand and Frank, 2015).**

1.2 Definition of ankylosis

Ankylosis is the fusion of a joint preventing all movement. In medicine, it defines as proliferation of bony tissue within a joint resulting in a rigid connection between the adjacent bony surfaces and complete immobilization. DA is an eruptive abnormality characterized by the fusion between the dentin or the cementum of the root and the surrounding bone, with the obliteration of the PDL that will be progressively replaced by bone tissue **(Eşian *et al*., 2022).**

1.3 Classification of dental ankylosis according to severity

A simple classification of ankylosed tooth can be described as mild, moderate or severe, if the ankylosis occur after the tooth emerged from the gingiva. According to this classification, "*mild*" is defined as being between the occlusal surface and the proximal contact (less than 2 mm of submergence), "*moderate*" shows infra-occlusion to the contact area and "*severe*" being anywhere below the interproximal contact point **(table 1.1) (Hua *et al*., 2019; Eşian *et al*., 2022).**

Table 1.1 A simple classification of IO with respective clinical examples and radiographs

Degree of IO	Clinical features	Example	Radiograph
None	No IO present between the occlusal level and the interproximal contact point of the adjacent teeth		
Mild	IO between the occlusal level and the interproximal contact point of the adjacent teeth		
Moderate	IO at the interproximal contact point of the adjacent teeth (note tooth in image shown is restored with onlay)		
Sever	IO below the interproximal contact point of the adjacent teeth (note that the adjacent tooth in this image is a canine)		

1.4 Etiology of dental ankylosis

In the last few years, two theories have been proposed in the etiology. The first theory identifies local factors as the main causes and the second theory focuses on genetic factors; however, so far, no responsible genes have been identified **(Hua *et al*., 2019).**

One of the theories states that any disruption in the continuity of the PDL caused by trauma can lead to the onset of the degenerative processes that will result in the fusion between tooth and bone. If the trauma produced limited lesions, a slight osteoclastic activity will be initiated on the root surface which involves resorption and repair, resulting in healing by depositing new fibers on the cement surface **(Lauridsen *et al*., 2020).**

If the PDL is completely destroyed, without healing capacity, there will be a gradual replacement of the root with bone and a progressive dental ankylosis

will occur. In previous studies on ankylosed teeth have been found that ankylosis is a local alteration related to dental or periodontal tissues rather than bone. **(Thumbigere-Math *et al*., 2018).**

Another theory involves that ankylosis is caused by a disturbed local metabolism, is based on the following considerations: If the roots of a deciduous tooth have been resorbed and the crown exfoliated, no trace of the periodontal membrane remains. Whether this disappearance is the result of a lysis or phagocytosis has never been shown, but whatever it is, it may very well hold the definitive answer concerning the etiology of tooth ankylosis **(fig. 1.2) (Trope, 2002).**

As a tooth erupts, there is apposition of bone within the alveolus. But what happens to the Sharpey'sfibers as the tooth moves occlusally? It seems that there are alternate phases of local resorption and deposition of bone on one side of the periodontal membrane and of cementum on the other, which makes possible appropriate adjustment of the Sharpey's fibers but leaves the periodontal membrane intact. When resorption of the deciduous roots finally does take place, the PDL ultimately disappears, but this normally occurs after (And not before) root resorption. If PDL disappearance were to precede root resorption, cementum and bone would come into contact, making fusion or ankylosis possible **(Cardozo and Hernández, 2021).**

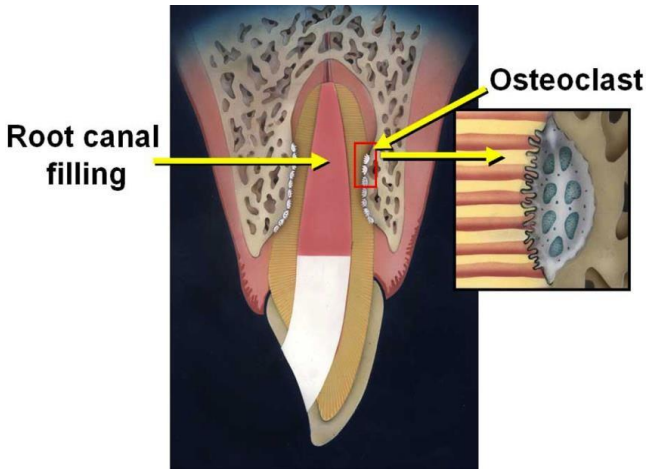

Figure (1.2) Diagrammatic representation of ankylosis with external replacement resorption **(Trope, 2002)**

1.5 Biological bases of Dental ankylosis (histological evidence)

Fuss *et al*. (2003) and Rosa *et al*. (2019) stated the following point in regard of the biological bases of DA:

1. The external surface of the root, teeth are surrounded by a PDL made up of specialized connective tissue that connects the tooth to the alveolar bone and also acts as a barrier between the alveolar bone and cementum.

2. It is believed that PDL cells are responsible not only for osteogenesis and bone resorption of the alveolar bone but also for fibrogenesis and fibroplasia of the ligament itself, as well as cementogenesis and the presence of cementoblasts on the root surface.

3. Maintenance of the space and the PDL depends on several factors, but the epithelial cell rests of Malassez seem to play a fundamental role in this function. They are arranged in the PDL in cellular cords similar to a net around the dental root.

4. The etiologies of the different types of root resorption have two phases: one due to chemical or mechanical damage to the protective tissues of the root and the other due to stimulation from infection or pressure.

5. The damage occurs in the non-mineralized tissue that covers the outer surface (cementoid). In severe trauma (intrusive luxation or avulsion with extensive time outside the mouth), damage to the root surface may be so great that repair with cementum replacement is not possible, and the bone may be in direct contact with the root surface without the interposed ligament apparatus.

6. Normally, bone is reabsorbed and physiologically undergoes neogenesis during its remodeling process without any specific stimulation. In cases of severe trauma, osteoclasts are in direct contact with the mineralized dentin. Therefore,resorption may occur without any extra stimulation and bone is formed over the exposed dentin **(fig. 1.3) (Rosa *et al*., 2019).**

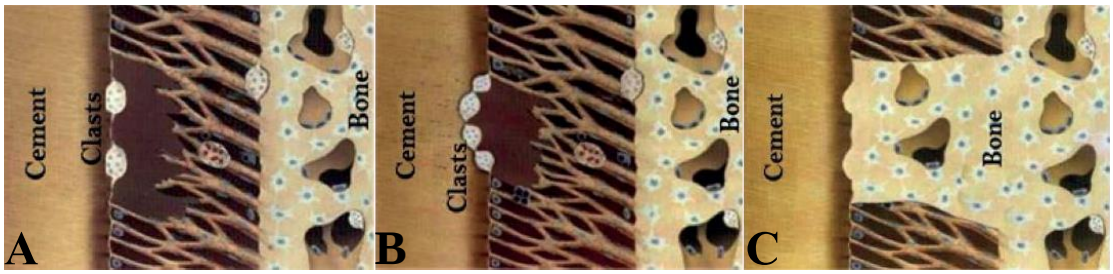

Figure (1.3) A. Initial damage to the root surface attacks by the clasts. **B.** Persistent damage to the root surface and the attacking clasts already in the root dentin. **C.** With dentin resorption,there is bone neogenesis stimulation and bone formation occurring over the exposed dentin **(Rosa *et al*., 2019).**

It has been shown that most ankylosed molars had osteoid tissue deposited in the furcation area with minimal osteoclastic activity, while teeth without successors showed ankylosis in the vicinity of the apex **(fig. 1.4) (Arhakis and Boutiou, 2016).**

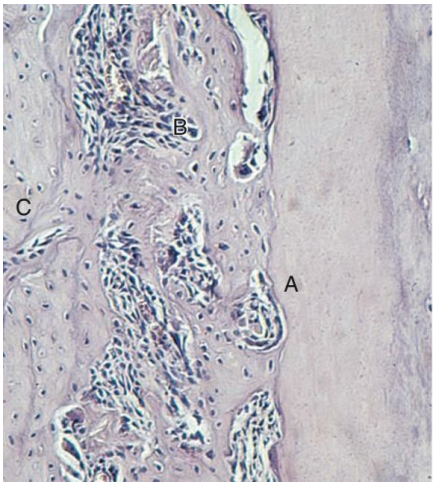

Figure (1.4) This photomicrograph demonstrates ankylosis between the cementum on the root surface. **A.** the alveolar bone proper and **B.** the area that was the PDL which is now filled in with bone and connective tissue and fused with the cementum and the alveolar bone proper **C.** cementum **(Arhakis, 2016).**

1.6 Prevalence of Dental Ankylosis

Multiple teeth ankylosis is as common as single instances, and a patient with one or two ankylosed teeth is likely to have other teeth become ankylosed later. Teeth that become intruded more than 6 mm or half of the clinical crown length within weeks after trauma become more susceptible to being ankylosed **(Alruwaithi *et al*., 2017).**

The differences in the results of the studies of the prevalence of DA were due to the different diagnostic criteria:

1.6.1 According to Age

According to previous study showed that DA occurs with a higher prevalence in the early stage of mixed dentition in children aged 6 to 9 years. The prevalence of this condition is ten times higher in decidual dentition than in permanent dentition, with a percentage of 1.3–8.9% in children aged 6–10 years in the first stage of mixed dentition **(Signori *et al*., 2011).**

1.6.2 According to Gender

Regarding the distribution by gender, there are no statistically significant differences between genders for the prevalence of ankylosis, but according to **(Odeh *et al*., 2016)** there was higher incidence in girls than boys, so accordingly female to male ratio is 6:5.

1.6.3 According to Teeth

The lower primary molars are ten times more affected compared to the upper molars **(Venza *et al*. 2018).**

Signori *et al*. (2011) and Eşian *et al*. (2022) showed that the first lower primary molar was the most frequently affected with higher incidence in quadrant three. This was followed by the second lower primary molar in quadrant three and then the first and second upper molars.

1.6.4 According to the severity DA

A higher percentage of cases with ankylosis had mild to moderate IO more than cases with severe IO **(Zúñiga *et al*., 2004).**

1.7 Diagnosis of dental ankylosis

It has been observed that DA can cause deleterious effects on the development of the dentition and for this reason timely diagnosis and an effective treatment plan are essential to prevent eruption abnormalities and functional alterations of the oral cavity **(Dias *et al*., 2012).**

The diagnosis of ankylosis is established after clinical and radiographic examination.

1.7.1 Clinical examination

Vertical percussion is a physical examination technique that aids greatly in the differential diagnosis of DA; it is positive when a hollow sound is detected. The altered sonority during percussion is due to the loss of the periodontal ligament; thus, forces are transmitted directly from one mineralized solid body to another and resonate along the tooth and the bone in which it is inserted, Ankylosed teeth lose the mobility of normal teeth. This is another important sign in the diagnosis of DA. If the process evolves, the teeth might present IO (**fig. 1.5) (Alruwaithi *et al*., 2017).**

The percussion sound relies on subjective assessment and a higher-pitched tone is more likely when at least 20% of the root surface is ankylosed. Such teeth can present immobility, but only when more than 10% of the root surface is ankylosed. Nevertheless, widespread root resorption on an immovable tooth is very allusive of ankylosis **(Cardozo and Hernández, 2021).**

The most important evidence of an ankylosed tooth is the inability to move with normal vertical dental alveolar growth or when it is subjected to orthodontic forces. As a result, it appears submerging into the alveolar process **(Alruwaithi *et al*., 2017).**

Figure (1.5) A case of an 8-year-old female patient with severe ankylosis of upper right D. Alterations are observed in the occlusal plane and severe IO **(Cardozo and Hernández, 2021).**

1.7.2 Radiographic examination

Radiological examination is essential for the diagnosis of ankylosis. Radiological images will show the fusion between the bone and the root surface as well as the absence of periodontal space. Additionally, the roots lose their opacity and, in cases of severe ankylosis, there is no clear delimitation from the surrounding bone **(fig. 1.6) (Eşian *et al*., 2022).**

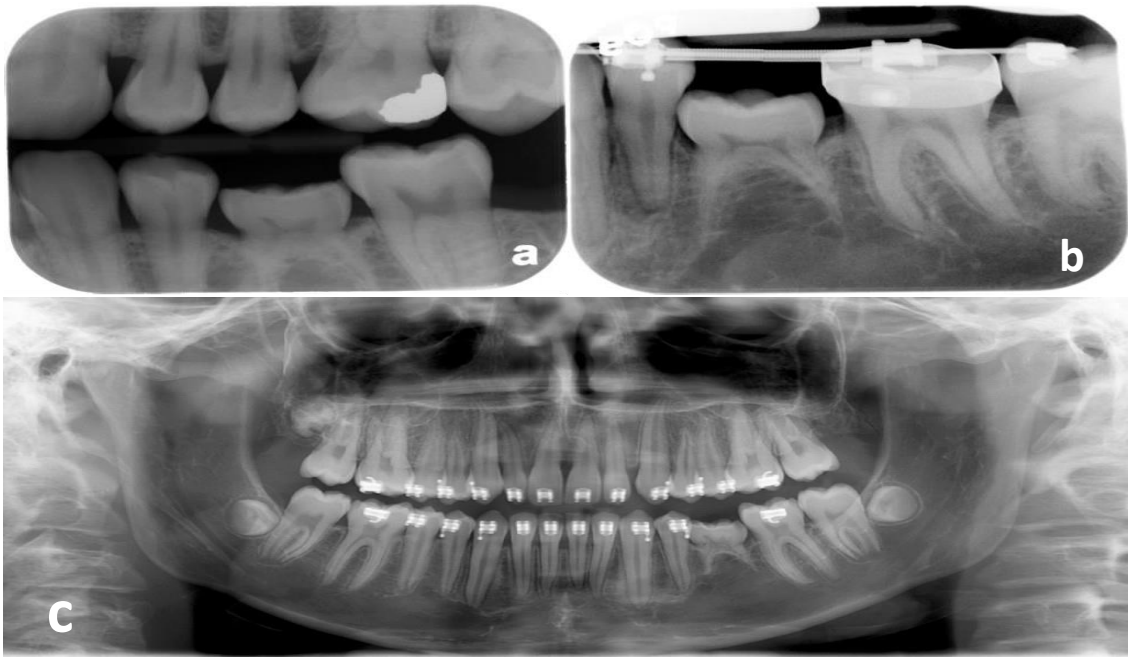

Figure (1.6) left mandibular primary second molar with step in the occlusal plane in: **A.** bite-wing radiograph. **B.** periapical radiograph. **C.** panoramic radiograph **(Eşian *et al*., 2022).**

One of the limitations of conventional radiographic aids is that in some cases the stiffened area is very small, or it may be located in the vestibular or lingual area, or at the level of the furcation, and the two-dimensional nature of the radiograph doesn't allow visualization. For this reason, some authors consider that the final diagnosis should be based on the clinical examination **(Cardozo and Hernández, 2021).**

In these cases, the investigator can use *computed tomography* (CT), an imaging examination that allows multiplanar reconstruction of the scanned volume, i.e., the visualization of axial, coronal, sagittal, and oblique images, as

well as *three-dimensional* (3D) reconstruction. Traditional CT and *cone-beam* CT (CBCT) are available. Through CBCT, it is possible to observe an area of continuity between the dentin and bone, thus diagnosing an area of alveolodental ankyloses **(fig. 1.7) (Rosa *et al*., 2019).**

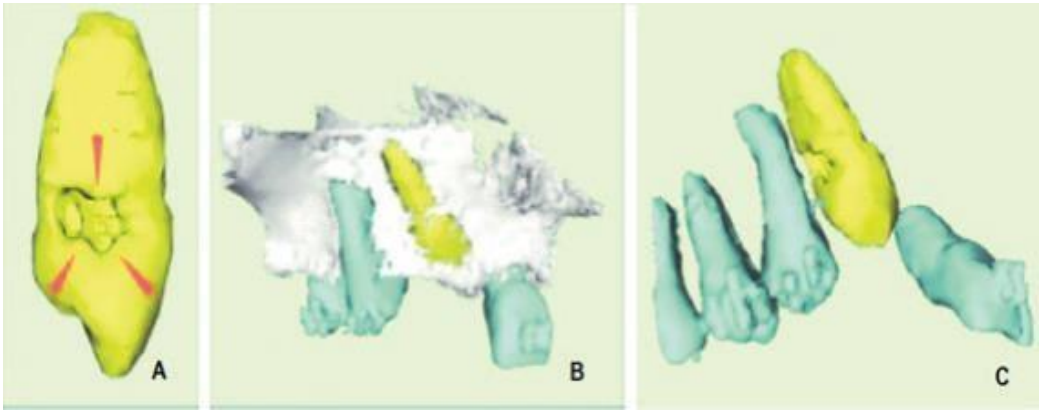

Figure (1.7) A 3D reconstruction of an area. **A.** Resorption in upper right canine due to ankylosis (arrows). **B.** Anatomical relationships between the bone and teeth. **C.** Anatomical relationships between the roots **(Rosa *et al*., 2019).**

1.8 Consequences of Dental ankylosis

The earlier that the ankylosis and IO occurs, the greater the potential for the problems. According to **Alruwaithi *et al*. (2017)** the following points were stated:

1. One of the negative sequelae is infra-positioning (submerged), due to the local arrest of the surrounding alveolar bone growth related to the continuous skeletal growth and development.
2. The presence of ankylosed teeth may complicate the eruption and development of the permanent dentition. Hypoplasia, deflection, or impaction of succedaneous teeth may happen.
3. Localized or generalized loss of needed arch length, tipping of adjacent teeth over the ankylosed tooth, or Super-eruption of the antagonist (until it reaches a contact point with the submerged tooth which is below the occlusal plane) **(fig. 1.8) (Hua *et al*., 2019).**

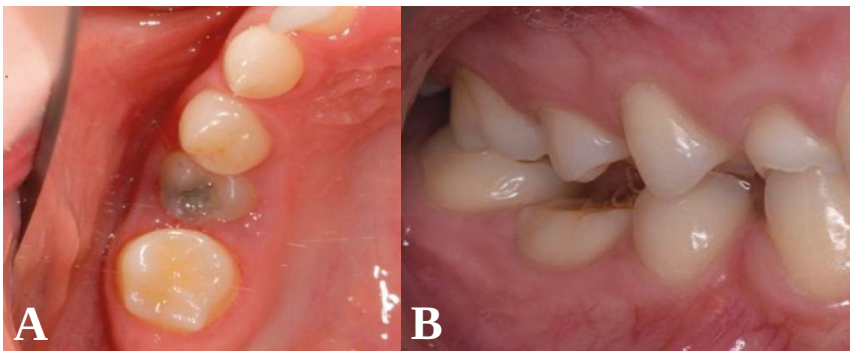

Figure (1.8) A. Tipping of upper right 4 distally adjacent to infraoccluded upper right E. **B.** Over-eruption of upper right 5 against infraoccluded lower right E **(Hua *et al*., 2019).**

4. Increased susceptibility of caries and periodontal disease to the neighboring teeth, as well as the submerged tooth, may also be a consequence.
5. High incidence of crossbites and dental aplasia. Most crossbites involve the buccal segments and/or anterior segments. It may be responsible for posterior open bite that subsequently leads to a tongue habit. Dental asymmetry and midline deviation, all those may result in malocclusion.

1.8.1 Effects of ankylosis on shedding of primary teeth and eruption of permanent teeth

Ankylosis, is the most common local cause of delayed deciduous tooth exfoliation. Ankylosed teeth will remain stationary while adjacent teeth continue to erupt through continued deposition of alveolar bone, giving the clinical impression of IO. This also leads to the over-retention of the deciduous tooth and complicate the eruption and the development of its successor **(Peedikayil, 2011).**

1.9 Treatment strategies

The treatment modalities depend on a number of factors including age of the patient, presence of a permanent successor, the time of diagnosis in relation to a patient's growth spurt, and the malocclusion present **(Hua *et al*., 2019).**

1.9.1 Children with permanent successors below the ankylosed primary molars.

In instances of ankylosed primary molars, the eruption of the underlying premolar teeth needs to be closely monitored radiographically. Without intervention, most cases (around 92%) of the ankylosed primary molar exfoliates with normal eruption of the permanent successor although with temporary delay of 6 months and therefore requires no intervention only monitoring and observation **(Kennedy, 2009).**

In contrast, the cases where the ankylosed teeth did not exfoliate naturally and required extraction. Radiographic assessment is essential for the practitioner managing the child patient so that eruption deviations can be handled with extraction of the infra-erupted primary molar and space management procedures, such as a lingual holding arch in the mandibular arch and a Nance space maintainer in the maxillary arch. Early removal of an ankylosed primary molar will require longer space management through the transitional dentition; by contrast, late removal can accelerate premolar eruption and reduce space management **(Hua *et al*., 2019).**

1.9.2 Children without a permanent successor beneath ankylosed primary molars

The status of the primary molar crown, roots, restorative status, and alveolar support in conjunction with its level to the occlusal plane all need consideration. Decisions made in the mixed dentition can significantly impact the overall management of the occlusion. It is therefore prudent for an orthodontist to be consulted relative to situations where there are missing teeth especially as missing teeth are associated with other eruption problems. The long-term decision that has to be made is whether the ankylosed primary molar will be maintained in the arch or whether extraction is indicated followed by either space closure, or space retention followed by restorative replacement, or a transplant treatment plan **(Sabri, 2008).**

Kennedy (2009) and Hua *et al*. (2019) stated several goals that need to be addressed when managing patients with retained second primary molars that show no permanent successors:

1. To establish the proper space in the arch for the missing tooth is a major goal. The leeway space is mainly due to the difference in widths of the mandibular second primary molar versus the narrower underlying permanent second premolar **(fig 1.9) (Hua *et al*., 2019).**

Interproximal reduction of the approximately 10 mm retained mandibular second primary molar in conjunction with restoration, approximates the mesiodistal width closer to the average 7.5 mm width of the absent second premolar, thereby facilitating Class I molar and canine occlusion. This strategy is limited by the size of the pulp, the curvature of the primary second molar roots and their proximity to the adjacent first permanent molar and premolar. When this interproximal reduction is done on the second primary molar, the clinician should not challenge the pulp horns by excessive reduction, as this may cause pulpal inflammation and could stimulate premature root resorption **(Tieu *et al*., 2013).**

Figure (1.9) Retained ankylosed second primary molar takes up too much space when unreduced, causing half cusp Class II molar with Class I canine **(kennedy, 2009).**

2. To maintain the integrity of the occlusal table if the retained primary tooth is ankylosed

This can be done by building up the primary tooth with composite or a *preformed metal crown* (PMC) to prevent tipping of adjacent teeth and to restore the occlusion to the correct height, thereby preventing opposing tooth supra-eruption. One potential disadvantage of a PMC is the risk of over-sizing the retained primary molar and compromising the leeway space **(fig. 1.10) (Kennedy, 2009; Arhakis and Boutiou, 2016).**

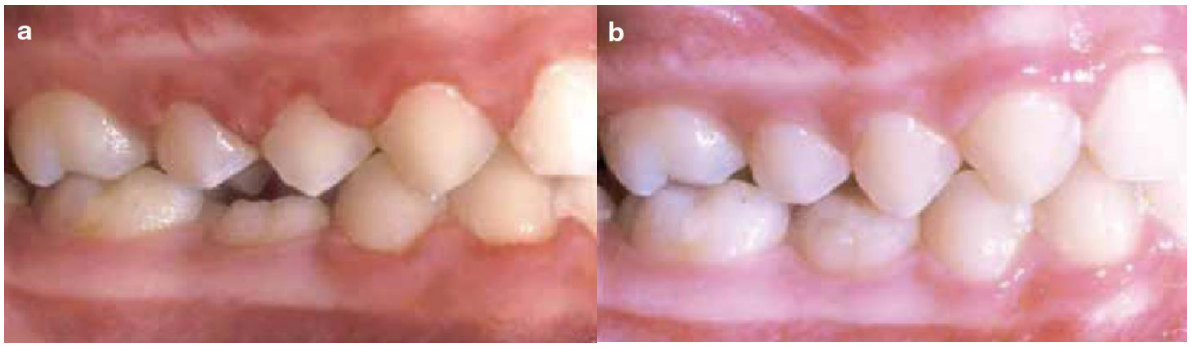

Figure (1.10) A photograph showing: **A.** Moderate IO and interproximal reduction of mandibular second primary molar; **B.** occlusal surface has been restored with composite to maintain arch integrity and prevent supra-eruption of opposing teeth **(Kennedy, 2009).**

3. To ensure that the alveolar ridge is preserved in instances where the long-term treatment plan involves prosthetic replacement of the missingtooth after extraction of the ankylosed primary molar.

When the IO is severe in a young patient, it is imprudent and even impossible to build the occlusal table up with either composite resin or a PMC, as progressive vertical growth will take the tooth out of occlusion. In such instances extraction is appropriate. When the primary molar is extracted in the absence of underlying permanent successors, there will be alveolar bone loss. This alveolar bone is usually necessary for future prosthetic replacement with an implant-supported crown. **(fig. 1.11) (Hua *et al*., 2019).**

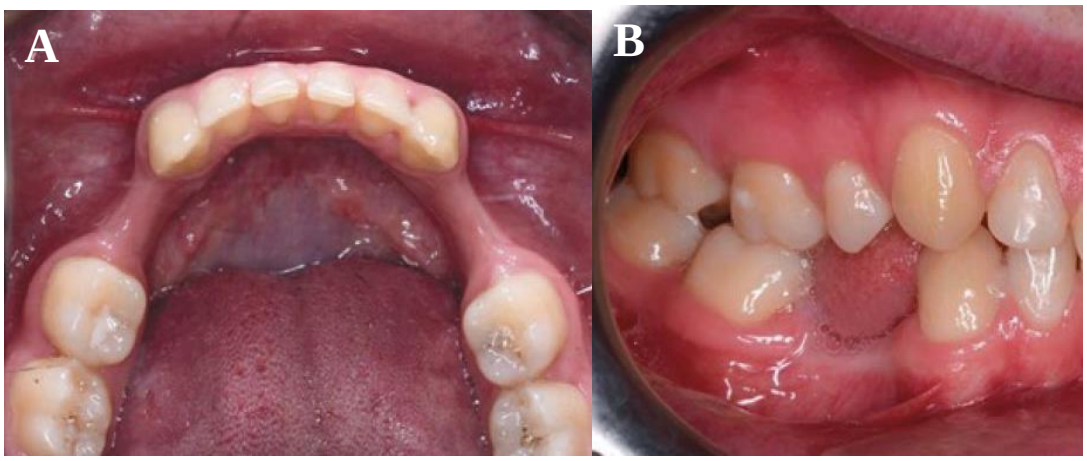

Figure (1.11) A. Occlusal view shows a horizontal bony defect. **B.** Right side buccal view shows a vertical defect in the same patient **(Hua *et al*., 2019).**

4. To ensure that the lower incisor position is maintained in the most favorable position.

When the patient has a normal overjet, there is no detriment to the facial profile by excessive retraction of the lower incisors. Patients with minimal crowding, deep overbites, retrusive incisors, decreased anterior lower facial height and flat mandibular plane angles are usually best treated with a non-extraction approach. Therefore, in patients with these characteristics, second primary molars should be retained for as long as possible, provided there is good root structure and absence of IO and they are interproximally reduced **(Arhakis and Boutiou, 2016).**

Alternatively, if the ankylosis is progressive, extraction and transplantation, or extraction and space retention for future prosthetic replacement is appropriate. In patients with significant crowding who demonstrate infraoccluded primary molars with absent permanent successors, a modified serial extraction program may be appropriate under the direction of an orthodontist **(Tieu *et al*., 2013).**

1.10 Ankylosis in permanent teeth

Ankylosis of tooth root to alveolar bone is the most commonly reported PDL complication following replantation of avulsed permanent teeth. When teeth are replanted after being avulsed, the repair process sometimes results in ankylosis because the cementum of the root and the alveolar bone have fused together. It has also been shown to develop in approximately 70% of incisors that had been intruded greater than one-half of the clinical crown. When DA of a maxillary incisor occurs in a growing child, the ankylosed tooth fails to move along with the remaining alveolar process during vertical growth. Thus, the ankylosed tooth appears gradually more impacted and often becomes esthetically objectionable **(fig. 1.12) (Kofod *et al*., 2005).**

Figure (1.12) intraoral photographs of maxillary left incisor. Note excessivelylong clinical crown with gingival margin that does not match margins on adjacent teeth **(Kofod *et al*., 2005).**

1.10.1 Treatment options

The choice of treatment for displaced ankylosed teeth depends on the severity of IO and replacement resorption, the preference and experience of the clinician and patient age (facial growth and dental development) and expectations **(De Souza *et al*., 2010).**

Treatment of an ankylosed permanent incisor in the past most often included surgical removal of the ankylosed tooth and replacement with a fixed or removable prosthesis. Because the positive diagnosis of ankylosis is based on the lack of vertical alveolar growth, a significant vertical and horizontal alveolar defect will exist if the ankylosed tooth is surgically removed after it has been retained during the remaining growth spurt **(Campbell *et al*., 2007).**

De Souza *et al*. (2010) summarized treatments as follows:

1. *Periodical follow-up* of the ankylosed teeth with possible composite build-up for any minor IO.

2. *Repositioning of the ankylosed teeth.*

Interventions for ankylosis that preserve the crown include surgical dislodgement and repositioning. It involves the mechanical breakage of the bridge between the tooth and the surrounding bone and is said to permit the tooth to resume eruption. The tooth can be placed a few millimeters from its original position and a flexible splint is inserted for a few days. Segmental osteotomy-sectioning and repositioning the alveolar bone including the ankylosed teeth can be used **(fig. 1.13) (You *et al*., 2012).**

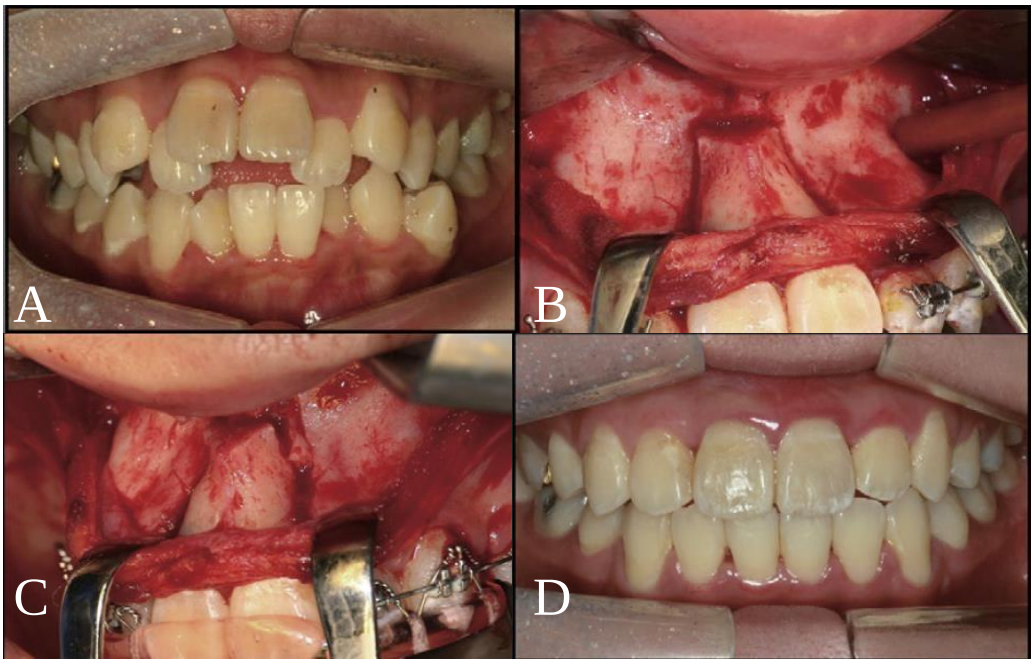

Figure (1.13) A. Pre-treatment intraoral photographs. **B.** Vertical and occlusally diverging osteotomy. **C.** repositioning of the dento-osseous segment with the preformed splint and autogenous bone graft in the bony gap. **D.** Post-treatment intraoral photographs **(You *et al*., 2012).**

3. *Autotransplantation*

Autotransplantation of a premolar to the ankylosed tooth position may provide a long-lasting physiological and aesthetic solution. It is recommended when the premolar root is less than three quarters developed (the first lower premolar is the preferred choice). In adolescents over 12 to 14 years, tooth

transplantation may be no longer due to a higher chance of complications associated with transplanted teeth with complete formed roots **(fig. 1.14) (Tsurumachi and Kuno, 2011).**

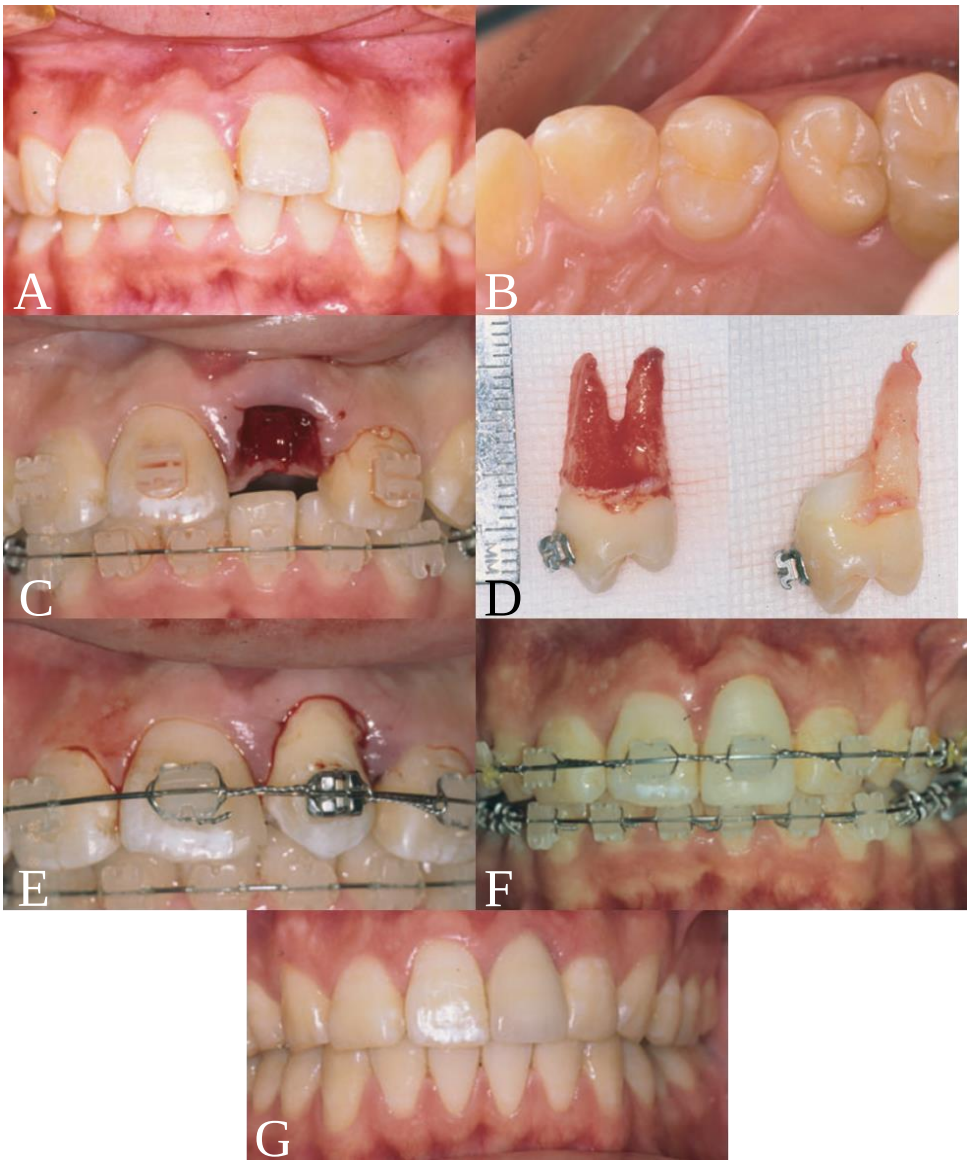

Figure (1.14) A. Preoperative intra-oral view of the ankylosed tooth 21. **B.** Preoperative palatal view of the maxillary first premolar. **C.** Buccal view of the extraction socket. **D.** The extracted first premolar with two roots and then the buccal root was removed and filled with composite resin. **E.** Transplanted tooth was splinted to adjacent teeth with wire. **F.** Two-year follow-up clinical view during orthodontic treatment. **G.** Postoperative intra-oral buccal view 7 years after transplantation **(Tsurumachi and Kuno, 2011).**

4. *Conventional prosthodontics and dental implants*

Another option is to remove the ankylosed teeth and to insert dental prostheses or implants, which is more recommended for adults. Height of jawbones should be maintained for adequate aesthetics and function, so decoronation (crown removal beneath surrounding bone) is proposed as an alternative to conventional tooth extraction **(fig. 1.15) (Calasans-Maia *et al.*, 2014).**

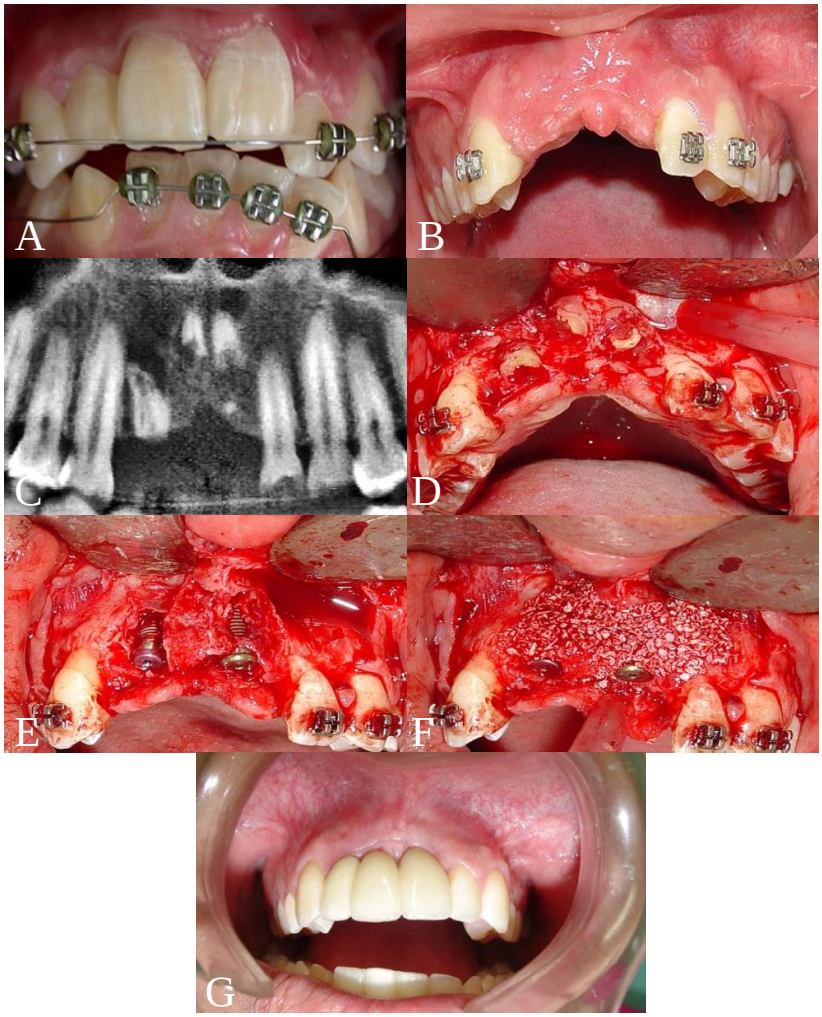

Figure (1.15). **A.** Clinical aspects of the infraposition of the ankylosed teeth. **B.** Intraoral aspect 5 years after decoronation. **C.** CT scan showing the vertical bone augmentation after decoronation procedure. **D.** Clinical reminiscent roots. **E.** Both implants placed. **F.** particulate xenograft covering the buccal implants dehiscences.**G.** Six months after prosthetic rehabilitation with a porcelain bridge supported by two implants **(Calasans-Maia *et al.*, 2014).**

5. *Extraction and orthodontic space closure*

Orthodontic space closure after the early loss of the traumatized tooth may provide an aesthetic solution as well as rehabilitation of the alveolar bone ridge. Unfortunately, limitations such as the underlying malocclusion, dental and skeletal age, teeth involved (systemic health, periodontal status, tooth shape and size), the need for compensatory extractions or reshaping of teeth as well as cost and compliance limit this option to well selected cases **(fig. 1.16) (Krutzen *et al*., 2022).**

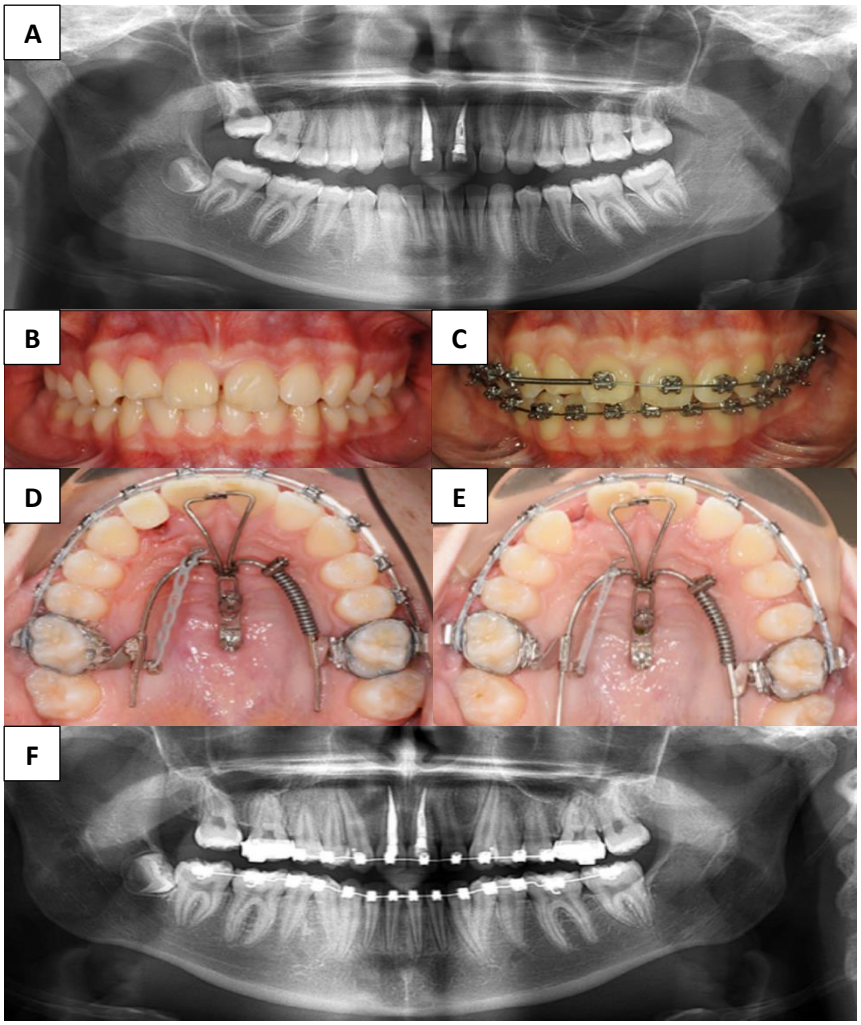

Figure (1.16) A. Pre-treatment panoramic radiograph. **B.** Pre-treatment intraoral photographs of the patient at 13 years of age. **C.** After alignment for 12 weeks after the bracket of the maxillary right lateral incisor was removed. **D.** After extraction, for esthetic reasons, the crown of the extracted maxillary right lateral incisor was temporarily attached to the archwire. **E.** After 4 months of mesialization of the maxillary posterior teeth on the right side, the pontic was removed. **F.** Panoramic radiograph after space closure **(Krutzen *et al*., 2022).**

Chapter two: Conclusion

1. DA in primary dentition is a frequent alteration, which presents a multifactorial etiology, which generates the fusion between the tooth and the alveolar bone due to the obliteration of the periodontal ligament.
2. Taking all these factors into account, if an infraoccluded or ankylosed primary tooth is observed, it should not be neglected. Early recognition and the appropriate meddling at the right time will make for a much uncomplicated treatment plan with long-standing results.
3. knowledge of the clinical and radiographic characteristics and biological principles of ankylosis is fundamental for the diagnosis and proper management of involved teeth.
4. The selection of treatment modalities is contingent upon various factors, which encompass the age of the patient, the existence of a permanent successor, the timing of diagnosis in relation to the patient's growth spurt, and the prevailing malocclusion.
5. When the IO is not progressive, then observation is appropriate. Only when there is severe disruption to the occlusion and/or the underlying premolar, extraction and space management may be appropriate.
6. When the ankylosed primary molar has no underlying premolar, orthodontic input is needed to determine if extraction and space closure, extraction and transplantation or extraction and prosthetic replacement is the best plan.

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