Republic of Iraq Ministry
of Higher Education and
Scientific Research
University of Baghdad
College of Dentistry

Delayed Tooth Eruption

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

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May/2023

Certification of the Supervisor

I certify that this project entitled " Delayed Tooth Eruption " was prepared by the fifth-year student Rawan Ali Hussein Fulfilment 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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Date

Dedication

To God for providing me with good health, strength, and understanding to carry on with my education even when the going looked difficult to endure.

To my supervisor, who gave me the courage, commitment, and awareness to follow the best possible path, with incomparable style.

This project is dedicated to my parents for their emotional and financial support, and for their continuous prayers.

To my sister, who has been a tremendous support to me at every moment of my life.

To my brother for his support and encouragement.

Acknowledgment

My faithful thanks and all gratefulness to "Allah", God of the world, Most Gracious, Most Merciful for leading and helping me to perform this project.

I would like to thank **Prof Dr. Rughad Abd Alrazaq Muhmmad**, Dean of the College of Dentistry.

My sincere thanks to **Prof Dr. Dhea H. AL-Groosh**, head of the Orthodontics Department, and all professors and seniors in the department for their pleasant cooperation.

My deepest appreciation and heartfelt gratitude go my supervisor**, Assist Prof Dr. Noor Muhammed Hasan Garma**, for her unfailing collaboration and scientific guidance.

Finally, I'd like to thank my family for their unwavering support and encouragement throughout my journey. Their love and guidance have been instrumental in shaping me into the person I am today. Without their constant motivation, I would not have been able to overcome the challenges that I faced along the way. I am truly grateful for their presence in my life, and I hope to make them proud with my future endeavors.

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ABBREVIATION	MEANING
ACTH	adrenocorticotropic hormone
CDE	chronologically delayed eruption
CCD	Cleidocranial dysplasia
CSF-1	Colony stimulating factor -1
CTSK	Cathepsin K
DTE	Delayed tooth eruption
DF	dental follicle
ETC	et cetera
ET AL	et alia
IL-A1	Interleukin-a1
M	Median age of eruption
PDL	periodontal ligament
PTH	Parathyroid hormone
OPG	Osteoprotegerin
RANK	Receptor activator of nuclear factor kappa-B
RANKL	Receptor activator of nuclear factor kappa-B ligand
RANKL-FC	Receptor activator of nuclear factor kappa-B ligand -fragment crystallizable
RUNX2	Runt-related transcription factor 2
SD	standard deviation
TDIS	Traumatic dental injuries
TNF	Tumour necrosis factor
µM	micro Meter

Introduction

The eruption is a physiologic process that strongly influences the normal development of the craniofacial complex **(Suri *et al*., 2004)**. The eruption of deciduous teeth and their exfoliation, followed by the eruption of permanent dentition, is an orderly, sequential, and age-specific event and is considered an important milestone during a child's development **(Peedikayil, 2011)**. Delayed tooth eruption (DTE) is a pathologic condition that is the most commonly encountered deviation from normal eruption time **(Suri *et al*., 2004; Ramos, 2006)**. A delay in an eruption can directly affect the accuracy of the diagnosis, overall treatment planning, and timing of treatment for the orthodontic patient **(Suri *et al*., 2004)**.

There can be variations in the timing of tooth eruptions. Significant deviations from established norms should be addressed with further examination of the patient's local and systemic conditions and genetic disorders. In patients with DTE, careful and accurate diagnosis and treatment planning will allow the clinician to perform orthodontic treatment at the proper stage and might reduce the duration of orthodontic treatment **(Park *et al*., 2013)**.

DTE is a common pathologic condition that is often encountered by dentists. Dentists should have enough knowledge about DTE. The knowledge includes a comprehensive interview, a proper clinical examination, cooperation with the expert, and establishing a diagnosis and treatment plan **(Suri *et al*., 2004)**.

The aim of study

This review was conducted to elucidate the underlying causes of delayed tooth eruption and the effective orthodontic interventions.

Chapter One

1. Tooth eruption

Tooth eruption is defined as a tooth's movement from its development site within the alveolar process to its functional position in the oral cavity **(Massler, 1941; Marwah, 2018)**. However, it is a dynamic process that encompasses completing root development, establishing the periodontium, and maintaining functional occlusion **(Suri et al., 2004)**.

The word "erupt" properly refers to cutting the tooth through the gum. It is derived from the Latin word erumpere, meaning "to break out." It is generally understood to mean the axial or occlusal movement of the tooth from its developmental position in the occlusal plane.While emergence of the tooth through the gingiva is the first clinical sign of eruption **(Marwah, 2018)**.

1.1 Theories of tooth eruption

Various theories and opinions have been proposed about the mechanism of tooth eruption, such as the theory of hydrostatic pressure in vessels and/or tissues, the theory of the role of the periodontal ligament (PDL) in the eruption process, the theory of mobility/contraction of PDL fibroblasts, the theory of root formation, and the bone remodeling theory. According to the prevailing opinion, the dental follicle (DF) has an important role in tooth eruption **(Kotsanos *et al.*, 2022)**.

Now, there is much evidence to implicate the fact that the eruption of teeth is critically dependent upon the presence of osteoclasts to create an eruption pathway through the alveolar bone. Mononuclear cells (osteoclast precursors) must be recruited into the DF prior to the onset of eruption. These cells, in turn, fuse to form osteoclasts and differentiate into mature osteoclasts that resorb alveolar bone, forming an eruption pathway for the tooth to exit its bony crypt **(Hua *et al.*, 2007; zhang *et al.*, 2023)**.

1.2 Pattern of tooth movement

Movements leading to eruption of tooth can be divided into three phases **(Marwah, 2018)**:

- ❖ Phase one: pre-eruptive phase, it is the movement of the developing tooth germs within the alveolar processes prior to root formation.
- ❖ Phase two: prefunctional eruptive or eruptive phase, begins with the initiation of the root formation and ends when the teeth reach occlusal contact.

Anatomic stages of tooth eruption (Figure 1) : -

Stage I: Preparatory stage (opening of the bone crypt).

Stage II: Migration of the tooth toward the oral epithelium.

Stage III: Emergence of the crown tip into the oral cavity (beginning of clinical eruption).

Stage IV: First occlusal contact.

Stage V: Full occlusal contact.

Stage VI: Continuous eruption

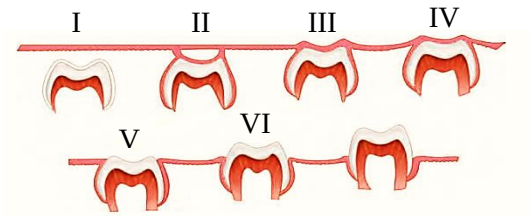

Figure 1: Tooth eruption sequence **(Marwah, 2018)**.

- ❖ Phase three: functional eruptive or posteruptive phase, begins when the teeth reach occlusion and continue for as long as each tooth remains in the oral cavity.

1.3 Speed of Eruption

The rate of tooth eruption is fairly slow in the intraosseous cavity (1–10 μm/day), but increases up to 75 μm/day once in the oral cavity **(Proffit *et al.*, 1991)**. The entire eruption occurred at night, and drift continues to occur via remodeling of the alveolar bone by PDL cells to ensure constant contact in occlusion **(Saffar *et al.*, 1997)**. The eruption speed is not uniform, as it moves at different speeds at different times. This range of velocities implies that bone resorption and formation must occur at variable speeds depending on the stage of eruption. During the intraosseous eruption, the rate of bone (and root) resorption determines the rate of eruption **(Retrouvey *et al.*, 2012)**.

1.4 Sequence and time of tooth eruption

In primary teeth the sequence of eruption is the same for both genders. In permanent teeth, the eruption sequence is similar to the primary teeth, except for the first molar, which is frequently the first tooth to erupt. Girls precede in eruption time and this difference between genders may reach several months for the teeth that erupt last in the arches **(Kotsanos *et al.*, 2022)**. Time of teeth eruption can vary slightly from child to child, but any significant deviation from the expected timeline could be a cause for concern.

Table 1: Median age of eruption (M) with one standard deviation (SD) in years of permanent teeth and in months of primary teeth in Arab children **(Kotsanos *et al.*, 2022)**.

Permanent					Primary				
Tooth	Male		Female		Tooth	Male		Female	
Maxilla	M	SD	M	SD	Maxilla	M	SD	M	SD
Central incisor	7.25	0.89	7.11	0.78	Central incisor	10.5	0.7	10.6	0.6
Lateral incisor	8.45	1.18	8.07	0.94	Lateral incisor	12.9	0.6	13.1	0.6
Canine	11.56	1.51	11.09	1.43	Canine	20.6	0.6	19.8	0.7
First premolar	10.45	1.52	10.01	1.44	First molar	15.5	0.8	15.5	0.6
Second premolar	11.37	1.53	11.00	1.51	Second molar	27.7	0.6	27.7	0.6
First molar	6.35	0.67	6.20	0.85					
Second molar	12.61	1.41	12.32	1.42					
Mandible	M	SD	M	SD	Mandible	M	SD	M	SD
Central incisor	6.48	0.67	6.32	0.81	Central incisor	8.3	0.9	8.1	0.7
Lateral incisor	7.51	0.89	7.34	0.85	Lateral incisor	14.6	0.4	13.9	0.5
Canine	10.63	1.42	9.84	1.21	Canine	20.9	0.6	19.8	0.8
First premolar	10.54	1.48	10.12	1.40	First molar	16.1	0.8	15.8	0.6
Second premolar	11.73	1.58	11.20	1.55	Second molar	27.7	0.5	27.2	0.6
First molar	6.24	0.66	6.08	0.87					
Second molar	12.19	1.41	11.66	1.54					

1.5 Tooth eruption versus orthodontic tooth movement

Tooth eruption occurs as the result of a programmed and localized expression of molecules (RANK, CSF-1 ,TNF-a , etc…) needed for alveolar bone resorption and formation, whereas orthodontic tooth movement focuses on the expression of these molecules for resorption and expression after induction by a mechanical force **(Wise and King, 2008)**.

2. Delayed tooth eruption

‘’Delayed,” “late,” “retarded,” “depressed,” and “impaired” eruption. Root development has been taken as a basis for distinguishing some of these terms.

Under normal circumstances, tooth eruption begins when 3/4 of its final root length is established. Thus, if an erupted tooth has less root development than the expected 3/4 of length, its eruption is deemed premature, whereas if the tooth has developed more than the root length expected for eruption and remains unerupted, it should be defined as having delayed eruption. When the emergence of a tooth is more than two SDs from the mean of established norms for eruption times, it should be considered delayed eruption. “Late eruption” is used when a tooth’s eruption status is compared with chronologic eruption times defined by population studies **(Suri *et al*., 2004)**.

Primary or idiopathic failure of eruption is a condition described by **(Profitt and Vig, 1981)** where by non-ankylosed teeth fail to erupt fully or partially because of malfunction of the eruption mechanism. Embedded teeth are teeth with no obvious physical obstruction in their path; they remain unerupted usually because of a lack of eruptive force **(Suri *et al*., 2004)**. Submerged teeth refer to a clinical condition in which, teeth become ankylosed after eruption and lose their ability to maintain the continuous eruptive potential as the jaws grow. Such teeth then seem to lose contact with their antagonists and might eventually be more or less “reincluded” in the oral tissues. This condition should not be confused with chronologic delayed eruption **(Antoniades *et al*., 2002)**. Although many terms are used to characterize DTE, they all refer to two fundamental parameters that influence this phenomenon **(Seifi *et al*., 2013)**:-

1. expected tooth eruption time (chronologic age), as derived from population studies advantage of using chronologic norms of eruption lies in the ease of use although not necessarily representing biological age.
2. biologic eruption, as indicated by the progression of root development.

2.1 Causes of delayed tooth eruption

The aetiological factors of pathologic eruption are: local, systemic and genetic and idiopathic factors.

2.1.1 Local conditions

Physical obstruction is a common local cause of DTE these obstructions can result from many different causes such as :-

2.1.1.1 Supernumerary Teeth

Supernumerary teeth are a condition in which the number of teeth exceeds normal dentition. This phenomenon, also known as hyperdontia, occurs in various forms, locations, and numbers. With an incidence of 0.3%–0.8% in deciduous dentition and 1.5%–3.5% in permanent dentition **(Jang *et al.*, 2023)**. The tuberculate type being more common in cases with delayed eruption (Figure 2) **(Mitchell *et al.*, 1992)**.

The presence of supernumerary teeth should be suspected if the eruption of permanent teeth is delayed, ectopic, or asymmetric. Supernumerary teeth are mostly asymptomatic; however, they can cause complications such as cysts, root resorption of the adjacent teeth, eruption disturbances, and malocclusion. **(Jang *et al.*, 2023)**

Treatment planning and intervention timing vary depending on the location, development stage, and presence or absence of associated complications. While the immediate removal of supernumerary teeth may pose harmful risks to the adjacent teeth, delayed intervention may result in the loss of the eruption potential of the adjacent permanent teeth and subsequent need for additional surgery and orthodontic treatment. Diagnosing supernumerary teeth early and accurately is essential to avoid orthodontic treatment and additional surgical options and reduce complications (Figure 3), **(Jang *et al.*, 2023)**.

Figure 2: Clinical picture of upper anterior supernumerary tuberculate type **(Namdev *et al.*, 2012)**.

Figure 3: Delayed eruption of permanent upper central incisors due to retained primary upper incisors and the presence of supernumerary teeth **(Aldowsari *et al.*, 2022)**.

2.1.1.2 Mucosal barrier

The mucosal barrier has also been suggested as an etiologic factor in DTE. Any failure of the follicle of an erupting tooth to unite with the mucosa will entail a delay in the breakdown of the mucosa and constitute a barrier to emergence **(Suri *et al.*, 2004)**.

2.1.1.3 Gingival hyperplasia

Gingival hyperplasia due to hormonal imbalance, hereditary causes, vitamin C deficiency, or phenytoin drugs that causes an increase of dense connective tissue and the acellular collagen that can affect normal tooth eruption (**Katz *et al.*, 2002)**. The most common forms of gingival enlargement are induced by systemic drugs, including the antiseizure drug phenytoin, the immunosuppressor cyclosporin, and the calcium channel-blocke (Figure 4; 5), **(Coletta and Graner 2006)**.

Figure 4: Clinical appearance of the generalized gingival enlargement **(coletta *et al.*, 2006).**

2.1.1.4 Ankylosis

Ankylosis is the fusion of the cementum or dentin to the alveolar bone, which is the most common local cause of delayed deciduous tooth exfoliation **(Suri *et al.*, 2004**), (Figure 7). The mandibular primary molars are the teeth most often observed to be ankylosed. In unusual cases, all the primary molars may become firmly attached to the alveolar bone before their normal exfoliation time **(Dean, 2015)**.

Treatment depends upon whether the ankyloses is deciduous or permanent, the time of onset, the time of diagnosis, and the location of the affected tooth. There are six possible situations **(Biederman, 1962) :-**

- If the ankylosed tooth is deciduous and has a successor, the general rule is to extract immediately and, if necessary, to insert an appropriate space maintainer (Figure 6).
- If the tooth is deciduous and without a successor and the onset is early so that "submergence" is threatened, treatment involves extraction and space maintenance.
- If the tooth is deciduous and without a successor and the onset is late, proximal and occlusal contacts may be built up at maturity.
- If the ankylosed tooth is permanent and the onset is early, the tooth should be luxated. If repeated luxation proves ineffective, the tooth should be extracted. It should not be permitted to "submerge."
- If the onset of ankylosis is late, the permanent tooth should be luxated. If the attempt is unsuccessful and the tooth does not "submerge," it may be built up at maturity.
- A deeply "submerged" ankylosed tooth, deciduous or permanent, should be left undisturbed unless it is infected or constitutes an immediate or potential threat to the occlusion.

Figure 5: Band and loop space maintainer **(Marwah, 2018)**.

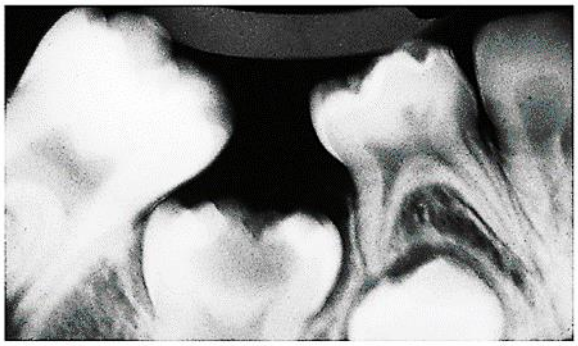

Figure 6: Ankylosed second primary molar with a caries lesion in the occlusal surface **(dean, 2015).**

2.1.1.5 Traumatic injuries

Traumatic dental injuries (TDIs) are relatively common in pediatric patients. Luxation injuries are the most common and most severe type because they not only damage the traumatized tooth and its supporting tissues but also present the potential risk of sequelae on the succeeding permanent teeth.

Delayed eruption may develop from the physical displacement of the permanent bud, the abnormal alterations in the connective tissue overlying the permanent tooth, or the formation of thick and fibrous gingiva post-traumatic healing.

TDIs to the primary dentition may cause deflection and delayed eruption of permanent dentition. It is important to monitor the position of unerupted permanent teeth following TDIs to primary teeth. The timing of surgical intervention is critical to avoid the need for future complicated orthodontic treatment **(Alfarraj *et al.*, 2022)**.

2.1.1.6 premature loss of deciduous teeth

The eruption of the succedaneous teeth is often delayed after the premature loss of deciduous teeth before the beginning of their root resorption. This can be explained by the abnormal changes that might occur in the connective tissue overlying the permanent tooth and the formation of thick, fibrous gingiva **(Suri *et al.*, 2004)**.

2.1.1.7 Arch-length deficiency

Arch-length deficiency is often mentioned as an etiologic factor for crowding and impactions. In a study of the relationship between the formation and eruption of the maxillary teeth and the skeletal pattern of the maxilla, a shortened palatal length was found to delay the eruption of the maxillary second molar, although no delay in tooth formation was observed **(Peedikayil, 2011)**.

2.1.1.8 X-radiation

X-radiation has also been shown to impair tooth eruption. Ankylosis of bone to tooth was the most relevant finding in irradiated animals. Root formation impairment, periodontal cell damage, and insufficient mandibular growth also seem to be linked to tooth eruption disturbances due to x-radiation **(Piloni and Ubios,1996)**.

2.1.1.9 Odontogenic cysts

In deciduous dentition, DTE due to obstruction is uncommon, but scar tissue (due to trauma) and pericoronal odontogenic cysts or neoplasms are the usual culprits in cases of obstruction **(Flaitz and Hicks, 2001)**. Odontomas are reported to be the most common of the odontogenic lesions associated with DTE **(Suri *et al*., 2004)**.

2.1.2 Systemic conditions

2.1.2.1 Nutrition

Nutritional deficiencies may cause malocclusion primarily by upsetting the dental developmental timetable and resulting in premature loss, prolonged retention, and abnormal eruptive paths **(Phulari, 2016)**.

Insufficient intake of carbohydrates, proteins, fats, iodine, calcium, magnesium, phosphorus, vitamin C, and vitamin D during the tooth growth and development period can cause DTE **(Lailasari *et al*,. 2018; Jairam *et al*,. 2020)**.

2.1.2.2 Endocrine diseases:

The endocrinal imbalance may predispose to the development of malocclusion. Thyroid hormones play an important role in the normal development of bones and teeth. Parathormone, released from the parathyroid glands, has an active role in calcium metabolism and thus is directly involved in the development of teeth and bone metabolism **(Phulari, 2016)**.

- **Hypothyroidism**

The thyroid gland's inability to produce enough thyroid hormones to meet the body's metabolic demands **(Gaitonde *et al*., 2012)**, which may cease the following **(Phulari, 2016) :**

- Retardation in the rate of calcium deposition in bone and teeth.
- Delaying tooth bud formation and eruption.
- Prolonged retention of primary and delayed eruption of permanent teeth.
- Irregularities in tooth arrangement and crowding of teeth may occur.

- **Hypopituitarism**

Hypopituitarism refers to adeficiency of pituitary hormones, a key risk factor being cortisol deficiency due to adrenocorticotropic hormone (ACTH) deficiency **(Higham *et al*., 2016)**. Consequently, the eruption and shedding of the teeth are delayed, as is the growth of the body in general. The dental arch has been reported to be smaller than normal; thus, it cannot accommodate all the teeth, so malocclusion develops **(Suri *et al*., 2004)**.

- **Hypoparathyroidism**

Hypoparathyroidism is a metabolic disorder characterized by low serum calcium and high serum phosphorus concentrations due to a deficiency or absence of parathyroid hormone secretion **(Mittal *et al*., 2014)**.

The two most frequent dental abnormalities are enamel hypoplasia (enamel is thin), delayed eruption, and there may be multiple unerupted teeth **(Mittal *et al*,. 2014)**.

2.1.3 Genetic disorders such as :

2.1.3.1 Down syndrome

Down syndrome, also denominated as trisomy 21, is a genetic alteration in which the affected individuals carry an extra chromosome 21 (**Moraes *et al.*, 2007)**. Several studies have reported a delay in the timing and sequence of eruption of the deciduous dentition in Down's syndrome, affecting particularly upper and lower central and lateral incisors, canines, and first molars. The eruption is not completed until the fourth or fifth year of life **(Jara *et al.*, 1993)**.

2.1.3.2 Cleidocranial dysplasia

Cleidocranial dysplasia (CCD) is a rare skeletal disorder with delayed osteoblast differentiation and autosomal dominant inheritance caused by mutations in the RUNX2 **(Abbass *et al.*, 2013)**. Serum alkaline phosphatase activity has been observed to be consistently reduced in patients suffering from CCD **(Unger *et al*,.2002)**. Decreased alkaline phosphatase levels could be one of the factors for a delayed eruption in CCD **(Zeichner-David *et al*,. 2003)**.

Each of the following dentoalveolar characteristics of CCD is probably present in all cases, to a greater or lesser degree **(Becker *et al*.,1997)** :

1. Over-retained deciduous teeth with unresorbed roots.
2. Supernumerary teeth that displace the developing permanent teeth and obstruct their eruption **(Becker *et al*.,1997)**. It is also suggested that remnants of the dental lamina are activated to form supernumerary teeth in CCD patients when the mineralization of the crowns of the permanent teeth is complete **(Unger *et al*,.2002)**. The presence of multiple supernumerary teeth may cause mechanical obstruction and may be the chief factor for the impaction of permanent teeth observed in CCD **(Manjunath *et al*,. 2008).**
3. Retarded eruption because of a lessened eruptive potential, although it is not entirely absent.
4. Reduced height of the lower third of the face and a skeletal Class III tendency due to under development of the maxilla and to an upward and forward

mandibular rotation. The vertical development of alveolar bone is markedly reduced, with a shallow buccal and lingual sulcus.

5. Serious (approximately 3 years) delay of the root development of the permanent teeth.

2.2 Clinical Implication

Deciduous teeth may be retained for a long time beyond their norm timing. Such teeth usually have no permanent successor or it is impacted. The upper lateral incisor is the most commonly retained in the primary dentition. Less frequently the mandibular second primary molars and rarely the lower central incisor. In permanent dentition, DTE is often seen in the region of the maxillary canines (**Marwah, 2014)**.

Clinically, DTE is any of the following conditions: the normal eruption time has been exceeded, a tooth is absent in the dental arch and shows no potential for eruption, an unerupted tooth has complete root formation, or a contralateral tooth has been erupted for at least 6 months **(Park *et al.*, 2013)**.

DTE can have a significant impact on a patient's oral health, such as occlusion dysfunction, temporo-mandibular joint dysfunction and chewing dysfunction, which can affect psychological health and quality of life in the adulthood. Some reports mentioned that abnormal erupted teeth might cause problems by ankylosis with alveolar bone and the formation of cysts of fistulas **(Hua *et al.*, 2007).**

2.3 Diagnosis

Diagnosis is established by the thorough evaluation of the familial and personal history, the general, facial and oral clinical examination; in a logical order that will facilitate the further correct establishment of the treatment plan. (Figure 10)**(Rãducanu and Feraru, 2007)**.

Physical evaluation should be done systematically. The intra-oral examination is included inspection and palpation. The inspection of soft tissue, and inspection left–right is important. It will be given the sign of significant dental eruption

deviations that are frequently unilateral. Inspection of infra-occlusal can be information of ankyloses. Palpation of the alveolar ridges will show the characteristic of erupting teeth; reveal prominences on the alveolar ridge **(Peedikayil, 2011)**.

In the radiographic examination, a panoramic radiograph (Figure 7) is useful for evaluating the extent of tooth development and the location of the developing teeth, estimating the time of emergence into the oral cavity of the teeth, and screening for radiolucent lesions associated with unerupted crowns. Nowadays, CBCT can accurately identify and locate the positions of deciduous and erupting permanent teeth. It is also possible to assess root resorption of deciduous teeth, the stages of tooth development, and the amount of bone surrounding developing permanent teeth **(park *et al*., 2013)**.

Figure 7: panoramic radiograph shows delayed eruption of permanent upper central incisors due to retained primary upper left central incisors **(Aldowsari *et al*., 2022)**.

2.4 Treatment

The treatment of DTE is based on etiology. Many techniques are recommended for DTE (Figure 11) **(Rãducanu and Feraru, 2007)**:-

- Surgical (extraction, obstacles removal, uncovering of affected teeth).
- Orthodontic (traction, creation, and maintenance of necessary eruption space).
- Replacement of extracted teeth with fixed/mobile prosthesis, autotransplant/ implant.

- Treatment of the systemic diseases that determined the chronic delayed eruption.

2.4.1 DTE with defective tooth development

➢ Primary teeth:-

- Determining if the dental malformation is localized/generalized.
- Observation or extraction – recommended at unerupted primary teeth with severe anomalies; the extraction's moment must take in to account the successor's development degree and the space necessary for their eruption.

➢ Permanent teeth:-

- Determining if the dental malformation is localized/generalized.
- Expectative until skeletal growth is finalized.
- Surgical uncovering without harming the dental support apparatus.
- The severely malformed teeth will be extracted if they present no prosthetic value **(Rãducanu and Feraru, 2007)**.

2.4.2 DTE with no obvious developmental defect in the affected tooth or teeth on the radiograph

In the absence of ectopic tooth position and physical obstruction, and if the biological eruption status is within normal limits, periodic observation is the recommended course of action. For a succedaneous tooth, if root formation is inadequate, extraction of the deciduous tooth or exposure to apply active orthodontic treatment is not justified. Root development should be followed by periodic radiographic examination. If the tooth is lagging in its eruption status, active treatment is recommended when more than 2/3 of the root has developed. **(Becker, 1998).**

The radiographic examination might also show an ectopic position of the developing tooth. Often, some deviations self-correct, but significant migration of the tooth usually requires extraction. Exposure accompanied by orthodontic traction is successful in patients in whom the ectopic teeth deviate more than 90°

from the normal eruptive path, autotransplantation might be an effective alternative **(Suri *et al*., 2004)**.

An obstruction causing delayed eruption might or might not be obvious on the radiographic survey should be treated with an uncovering procedure that includes enamel exposure **(Peedikayil, 2011)**.

When neoplasms (odontogenic or nonodontogenic) cause obstruction, the surgical approach is dictated by the biological behavior of the lesion. If the affected tooth is deep in the bone, the follicle around it should be left intact. When the affected tooth is in a superficial position, exposure of the enamel is done at tumor removal. Occasionally, the affected tooth must be removed. Four surgical approaches have been recommended for uncovering impacted teeth. These include gingivectomy, apically positioned flap, flap/ closed eruption, and the pre-orthodontic uncovering technique **(Suri *et al*., 2004)**.

Two opinions seem to exist regarding the management of the tooth delayed in eruption after removing the physical barrier. McDonald and Avery **(1999)** recommend exposure of the tooth delayed in eruption at the surgical removal of the barrier, but Houston and Tulley **(1992)** advocate removing the obstruction and providing sufficient space for the unerupted tooth to erupt spontaneously.

When arch length deficiency creates a physical obstruction, either expansion of the dental arches or extraction might be necessary to obtain the required space. Extraction of either the affected or adjacent teeth can be performed. Occasionally, several teeth in a quadrant might be unerupted, and this can present an orthodontic challenge because of the lack of adequate anchorage elements **(Rãducanu and Feraru , 2007)**. Osseointegrated implants might offer viable alternatives for anchorage in such cases **(Suri *et al*., 2004)**.

2.4.3 DTE Associated with systemic disorders

Whenever DTE is generalized, the patient should be examined for systemic

diseases affecting eruption. systemic disease treatment as previously mentioned based on etiology **(Rãducanu and Feraru , 2007)**.

2.4.4 Surgical orthodontic treatment

Surgical exposure of the impacted tooth may be required in addition to removing any obstruction. Early orthodontic traction can enhance facilitated eruption, which is why it's important to consider surgical exposure and bonding of an orthodontic attachment at the time of supernumerary removal. This attachment can then be used later if required to align the incisor and avoid the need for a second general anesthetic. making surgical exposure and bonding of an orthodontic attachment a prudent option **(Davies *et al*., 2008)**.

The success of surgical exposure combined with orthodontic traction exceeds 90%. A fixed orthodontic appliance is considered the ideal choice for young patients with good oral hygiene and high compliance. the fixed appliance can be useful for space creation, space maintenance, and the application of traction to the unerupted incisor if required. The first permanent molars, lateral incisors, and the contralateral central incisor tooth are usually included in the fixed appliance, as these are often the only permanent teeth that have erupted at this time (Figure 9), **(Seehra *et al*., 2018)**.

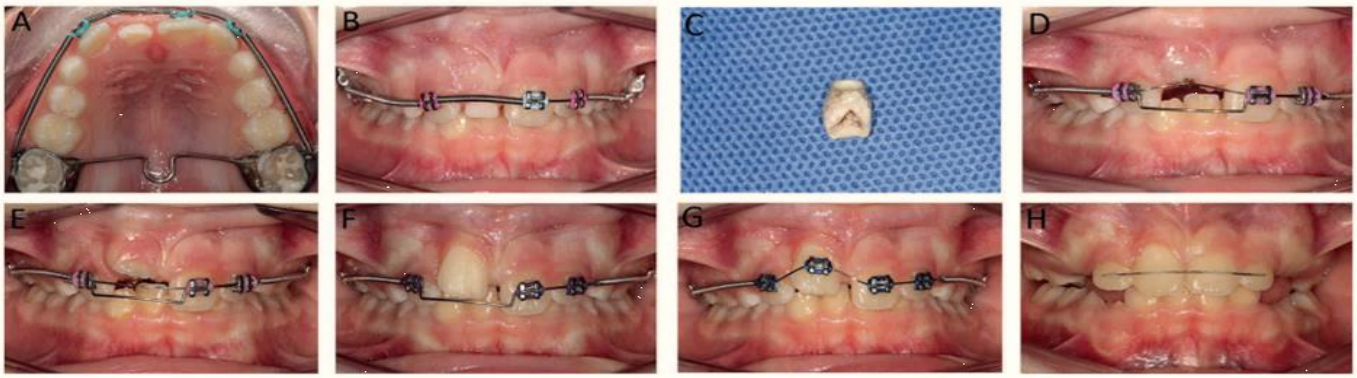

Figure 9: (A, B) Impeded eruption of an 11 due to the presence of a supernumerary tooth. An upper fixed appliance with a trans-palatal arch was placed; (C) The retained primary incisor was extracted along with the supernumerary tooth (D, E) the 11 surgically exposed with bonding of a gold chain and piggy-back mechanics instituted utilizing nickel-titanium and stainless steel archwires (F) Eruption of the 11; (G) Orthodontic bracket bonded to the 11 for final alignment; (H) Removal of the fixed appliance and placement of a labial bonded retainer for retention **(Seehra *et al*., 2018).**

2.4.4.1 Surgical techniques options

For an individual who is over nine years old and has a mature permanent tooth, it may be appropriate to perform a surgical exposure procedure either with an open or closed technique. This is especially true if the unerupted tooth is located high up. In cases where surgery is necessary to remove an obstruction, simultaneous closed exposure and bonding of an orthodontic attachment with a gold chain should be considered.

- **Open surgical exposure**

The open exposure of an unerupted permanent maxillary incisor, using a simple elliptical incision of the overlying soft tissue, is rarely indicated but may be useful when there is a soft tissue impaction, with the tooth occupying a very superficial position just beneath the mucosa **(Becker et al., 2002; Vanarsdall and Corn, 1977)**.

- **Closed eruption technique**

In the closed eruption technique, a mucoperiosteal flap incorporating the attached gingiva is raised and an attachment is bonded to the impacted tooth before the flap is replaced into its original position. The attachment should incorporate a gold chain or traction ligature to facilitate the application of orthodontic force. Ideally, the attachment should be low profile and bonded to the palatal surface of the unerupted tooth to allow orthodontic traction to be applied in the most favorable direction and to reduce the risk of fenestration of the attachment through the thin overlying alveolar mucosa as the tooth is aligned (Figure 10)**,(Seehra *et al*., 2018)**.

2.2.4.2 Open versus closed eruption techniques

Early studies demonstrated superior results for a closed eruption in terms of gingival, periodontal, and pulpal status. Longitudinal assessment of closed versus open eruption has reported longer clinical crowns and decreased bone support in association with open eruption **(Chaushu *et al*,. 2009)**.

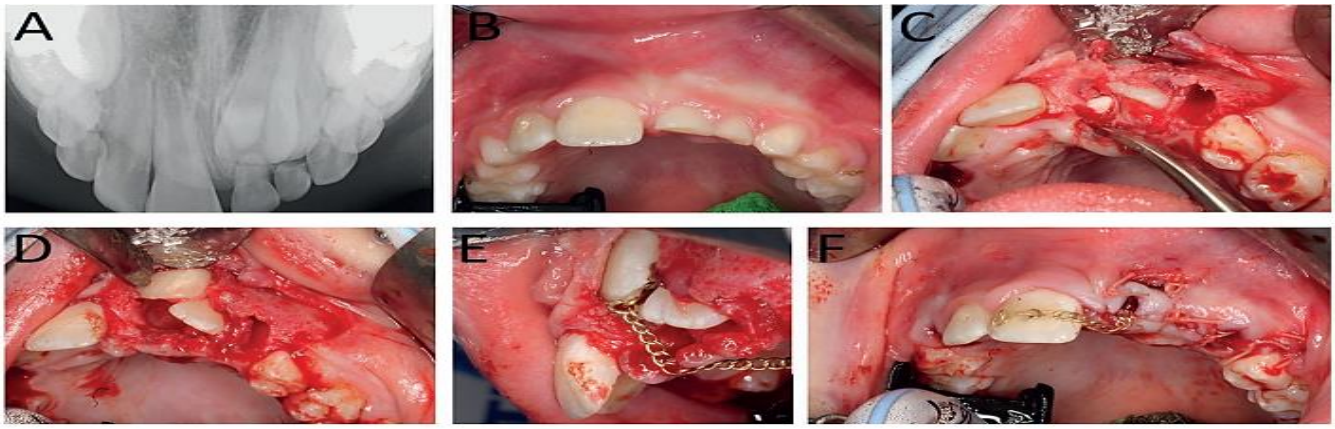

Figure 10: Closed eruption technique (A, B) An impacted 21 due to the presence of a supernumerary tooth; (C, D) Raising of a mucoperiosteal flap to surgically expose and identify the supernumerary tooth, which was palatal to the 21; (D) Removal of the supernumerary tooth and bonding of a gold chain attachment to the palatal surface of the 21; (E) Closure of the soft tissues and gold chain temporarily secured to the adjacent 11 with composite adhesive **(Seehra *et al.*, 2018).**

2.2.5 Molecular treatment strategy of delayed tooth eruption

In general, any method that triggers osteoclast production, differentiation, and function will be effective in the treatment of DTE. Stimulating osteoclast formation involves applying cytokines or small molecules, such as TNF-a, IL-1a, and MCP-1, in the local position of the affected tooth. Inducing bone loss by triggering osteoclast differentiation involves injecting small molecules associated with RANKL signaling, such as RANKL-Fc and OPG antibodies, into the oral mucosa of the affected tooth. Enhancing the function of osteoclasts involves injecting proteinases, such as CTSK, in the local position of the affected tooth to induce bone resorption and rebuild the pathway of tooth eruption **(Hua *et al*,. 2007; Zhage *et al*,. 2023)**

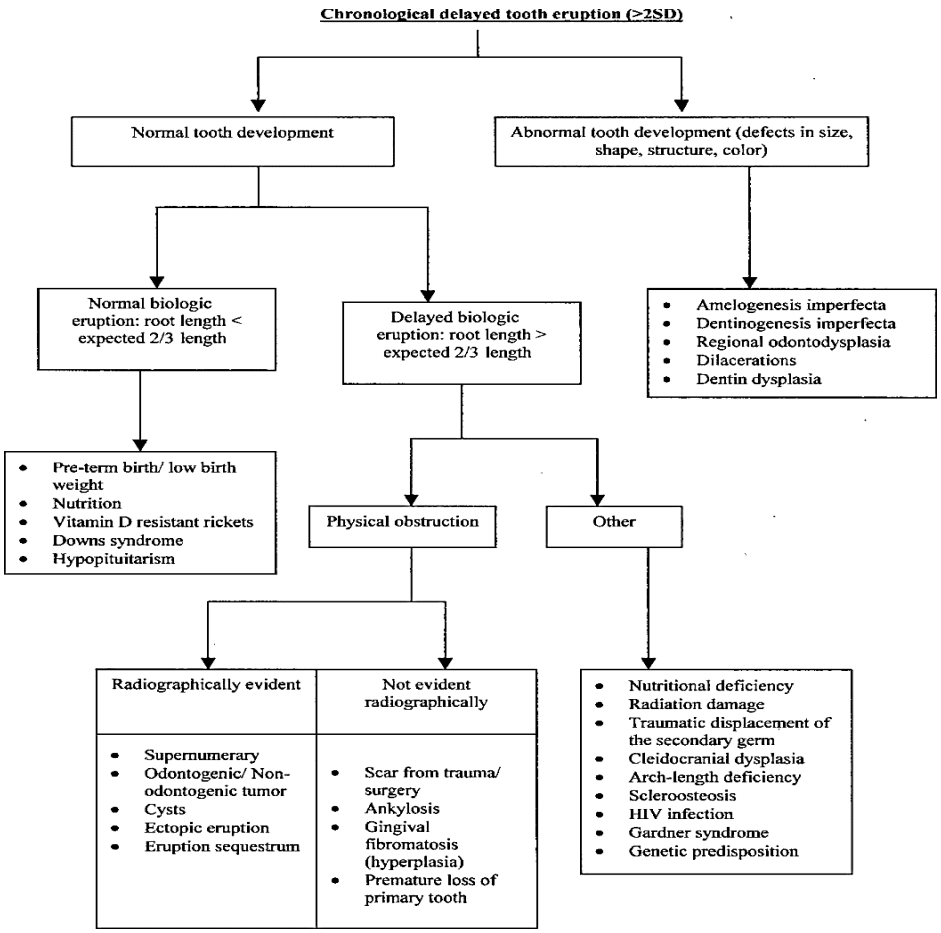

Figure 10: A diagnostic algorithm for DTE **(Suri *et al.*, 2004)**.

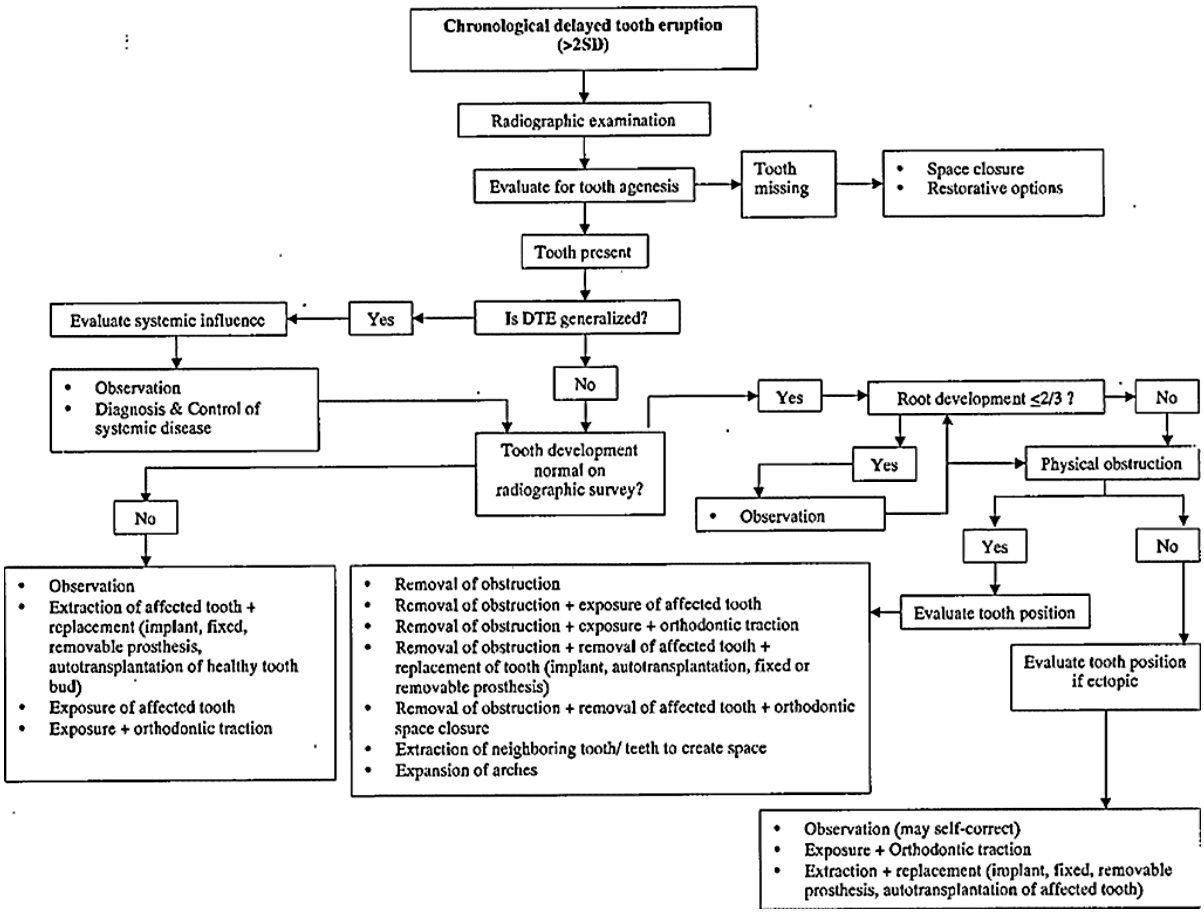

Figure 11: Flow chart of treatment options for DTE affecting permanent dentition **(Suri *et al.*, 2004)**.

3.Clinical cases

A 9 years girl has a supernumerary tooth that had been extracted when the patient was 7 years (Figure 13 (A)). However, the permanent tooth had not erupted. The first step was to determine the cause of the delayed eruption. In this case, fibrotic gingiva in the path of the eruption caused the delay. Next, the impacted tooth had to be located. As is the case for most maxillary incisors, the tooth was labially impacted, and it was located by palpation and was confirmed by obtaining a radiograph. The unerupted maxillary incisor was in a favorable labiolingual position, with no overt rotation or angulation (Figure 13 (B)). Both lateral incisors fully erupted and the apex of the unerupted maxillary central incisor near closure; as such, natural eruption was unlikely to occur .

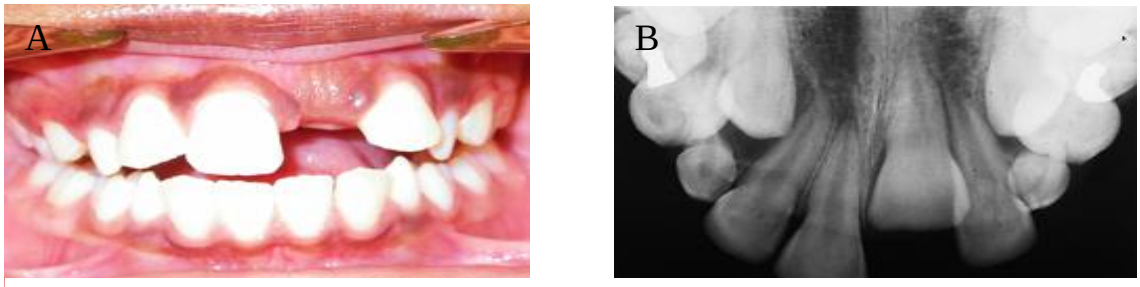

Figure 12: (A) Photograph shows the absence of the left maxillary central incisor. The right maxillary central incisor and both maxillary lateral incisors fully erupt. (B) Radiograph shows the unerupted maxillary left permanent incisor **(Shah and Kulkarni, 2010)**.

3.1 Treatment Mechanics

A partial fixed orthodontic appliance was constructed by bonding orthodontic bands to both of the maxillary permanent first molars and bracketing the erupted permanent incisors. A soft, flexible nickel–titanium archwire was attached to level the dental arch and to align and rotate the teeth in the anterior segment. Because space had been lost in the region of the unerupted maxillary incisor,(Figure 14 (A)) the archwire was changed to a rigid stainless steel wire An open coil was then inserted in the region of the unerupted maxillary incisor to

regain the slight space that had been lost because of drifting of adjacent teeth (Figure 13(B)).

Open surgical exposure of left maxillary central incisor was preformed by removing the gingival tissue overlying the labial surface of the tooth. An orthodontic bracket was then bonded to the tooth (Figure 13 (A)) (Figure 13 (B)).

A light extrusive force (20 g) was applied to guide the unerupted maxillary incisor into the dental arch by using elastic chain. The spring had sufficient pressure to just counterbalance the forces of the chain elastic. The tooth erupted rapidly (within three months) and was guided into occlusion (Figure 13 (C)). Once the maxillary incisor had reached the desired position in the dental arch, a final stage of leveling, alignment, and rotation was undertaken, followed by a period of retention. The patient and her mother were pleased with the esthetic result of the treatment (Figure 13 (D)) **(Shah and Kulkarni, 2010**).

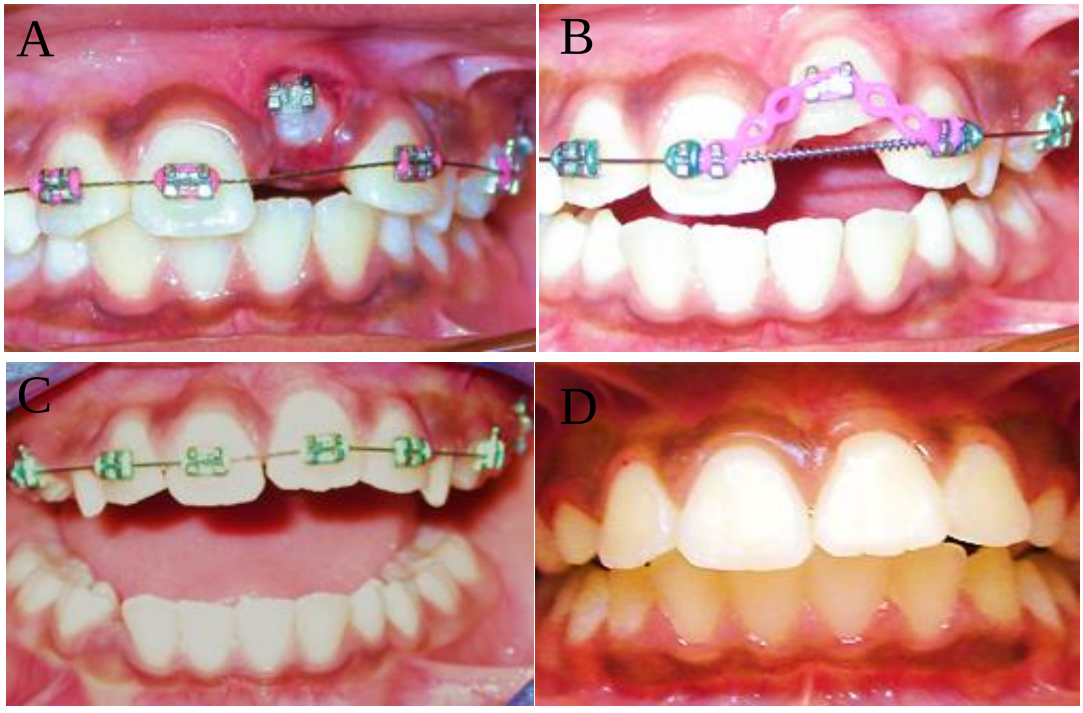

Figure 13: Treatment of delayed eruption of the left maxillary incisor (A) Photograph obtained after exposure and bonding of the left maxillary. (B) The left maxillary incisor has been incorporated into the partial fixed orthodontic appliance with chain elastics. (C) Three months after initiation of treatment. The left maxillary incisor has been guided into occlusion. (D) The esthetic appearance of the teeth has been restored. **(Shah and Kulkarni, 2010)**

Chapter two

Discussion

Eruption is considered to be late when it occurs more than 6 months beyond the average age limit of eruption for primary teeth and more than 1 year for permanent teeth **(Cameron, 2013)**.

Orthodontists are often in a sentry position to perform an early evaluation of craniofacial structures, both clinically and radiographically. Proper evaluation of DTE in orthodontic diagnosis and treatment requires a clear definition of the term and its significance. literature review propose a diagnostic algorithm that would enable the clinician to perform an accurate and thorough orthodontic diagnosis of the patient with DTE **(Suri *et al*., 2004)**.

Open surgical exposure of an unerupted tooth can be useful when there is a soft tissue impaction, with the tooth occupying a superficial position beneath the mucosa. The closed eruption technique uses a mucoperiosteal flap incorporating the attached gingiva raised, and an attachment is bonded to the user before the flap is replaced **(Seehra *et al*., 2018)**.

Some methods have been suggested to rescue the DTE. These include ‘removing the tooth affected by DTE, elimination of obstacles to eruption, exposure of effected teeth with or without orthodontic traction, and control of the system disease. To the young patients of DTE, these surgical or orthodontic treatments will increase their pain and mental burden. Furthermore, no approach aims to accelerate the biological process of tooth eruption and rescue this eruption disorder without surgical or orthodontic operation. Now, there are many evidences to implicate that eruption of teeth is critically dependent upon the presence of osteoclasts to create an eruption pathway through the alveolar bone. Triggering osteoclasts formation and activation might be potential treatment approaches for tooth eruption abnormality based on developmental biology was searched in literature **(Hua et al,. 2007; Zhang *et al*,. 2023).**

Chapter Three

Conclusions and Suggestions

Conclusions

1- Large deviation from the average tooth eruption standards alerts the orthodontist, who must thoroughly investigate the patient's oral and general development and thus track down as soon as possible the local dental anomalies as well as the systemic diseases that may disturb the craniofacial complex's functionality.
2- A complete patient evaluation leads to a diagnosis specifying and elaborating on the complex treatment plan (pedodontics, surgical, orthodontic, general).
3- There is a close relationship between proper management of delayed tooth eruption and orthodontic modalities.
4- The choice of different treatment modalities can play a primary role in the successful outcome of an orthodontic patient with DTE.
5- Using molecular biology can positively impact the choice of treatment plan and have a lower burden as compared to traditional surgical techniques.

Suggestions

1- Conduct an experimental study comparing the effect of different treatment options on the rate of the eruption.
2- Conduct a cross-sectional survey to evaluate the percentage of DTE among the students of the dental college of University of Baghdad.

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