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University of Baghdad
College of Dentistry

The Effect of Root Condition of Primary Teeth on the Development of the Permanent Successors

A Project Submitted to

The College of Dentistry, University of Baghdad, Department of Pedodontics and Prevention in Partial Fulfillment for the Bachelor of Dental Surgery

By

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Certification of the Supervisor

I certify that this project entitled **"The effect of root condition of primary teeth on the development of the permanent successors"** was prepared by the fifth-year student **Daniah Ahmed Azeez** under my supervision at the college of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry

Signature:

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Date:

Dedication

I dedicate this work to...

-The one who took care of me in my sickness and health, my beloved mom.

-The ones who supported me, believed in me and brought the best of me, my soulmates (my father and my brother).

-Every pediatric dentist who made me fall in love with this specialty.

-Every child who trusted me, ignited a passion in my heart and made me believe that I am talented .

-My amazing supervisor Dr. Noor M. Hassan who supported me through out this long journey.

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First of all, I thank **"Allah"** almighty for granting me the will and strength to accomplish this project, and I pray that his blessings upon me may continue throughout my life.

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Abbreviation	Meaning
HERS	Hertwig's epithelial root sheath
mm	Millimetre
TDI	Traumatic dental injuries

Introduction

The jaws of an infant can accommodate only a few small teeth. Because teeth, when formed, cannot increase in size, the larger jaws of the adult require not only more but also bigger teeth. This accommodation is accomplished with two dentitions. The first is the deciduous or primary dentition, and the second is the permanent or secondary dentition **(Nanci, 2018)**.

Due to the close relationship between the root apex of primary teeth and the bud of developing permanent successors, any lesion to the primary dentition can influence the eruption of the permanent teeth **(Villasenín *et al*., 2022)**. Severe damages can occur at the moment of the trauma, by direct impact of the root of the deciduous tooth on the permanent germ, or in the medium, as a consequence of post-traumatic complications **(Pugliesi *et al*., 2020)**. The severity of these consequences was highest among children less than 1 year old as morphologic and histologic differentiation will take place in the tooth bud at this time **(Tewari *et al*., 2018)**.

Children are especially vulnerable to dental trauma, especially in the first two years of life, when they are starting to walk and socialize **(Villasenín *et al*., 2022)**. Some authors report the highest occurrence in males, with the teeth most frequently involved the upper incisors **(Pugliesi *et al*., 2020)**. A major predisposing factor for dental injuries is increased overjet in which they are twice more frequent among children with protruding incisors than children with normal occlusion **(Saleem *et al*., 2010)**.

Parents do not know the value of the deciduous teeth as they think that it's going to shed and be replaced by new permanent teeth. They readily agree that they would give importance to permanent teeth than spend money on teeth that's eventually going to fall off. Therefore, providing anticipatory guidance regarding dental and oral development, fluoride status, non-nutritive sucking

habits, teething, injury prevention, oral hygiene instruction, and the effects of diet on the dentition are important components of the first dental visit **(Manohar and Mani, 2017)**.

Aim of the Study

The main purpose of this review was to present a number of conditions associated with primary teeth roots and their effect on the underlying developing permanent successors.

Chapter one: Review of Literature

1.1 Teeth development

The development of primary and permanent teeth occurs essentially in the same manner, although at different times. The entire primary dentition is initiated between 6 and 8 weeks of embryonic development; the successional permanent teeth between 20 weeks in utero and 10 months after birth; and the permanent molars between 20 weeks in utero (first molar) and 5 years of age (third molar).Aberrations in this pattern of development result in missing teeth or the formation of extra teeth **(Nanci, 2018)**.

1.1.1 Morphological development

Although tooth development is a continuous process, the developmental history of a tooth is divided into several morphologic ‘stages’ for descriptive purposes. While the size and shape of individual teeth are different, they pass through similar stages of development. They are named after the shape of the enamel organ (epithelial part of the tooth germ), and are called the bud, cap, and bell stages as follows **(Kumar, 2015)**:-

a) Bud stage

Simultaneous with the differentiation of each dental lamina, round or ovoid swellings arise from the basement membrane, corresponding to the future positions of the deciduous teeth (Fig. 1.1-A).

b) Cap stage

As the tooth bud continues to proliferate, unequal growth at different parts of the tooth bud leads to the cap stage, which is characterized by a shallow invagination on the deep surface of the bud (Fig. 1.1-B).

c) Bell stage

As the invagination of the epithelium deepens and its margins continue to grow, the enamel organ assumes a bell shape (Fig. 1.1-C). In the bell stage, crown shape is determined.

1.1.2 Histophysiological development

A number of physiologic growth processes participate in the progressive development of the teeth. Except for their initiation, which is a momentary event, these processes overlap considerably (Fig. 1.1), and many are continuous throughout the various morphologic stages of odontogenesis. Nevertheless, each physiologic process tends to predominate in one stage more than in another as follows **(Kumar, 2015; Rajkumar and Ramya, 2017; Ansari *et al*., 2019)**:-

a) Initiation

Initiation of tooth development depends on the epithelial–ectomesenchymal interaction. The dental lamina which forms as a result of such interaction has the ability to form enamel organs of the deciduous and permanent teeth.

b) Proliferation

The enamel organ formed due to initiation undergoes proliferation to give the crown of the tooth its final size and shape.

c) Histodifferentiation

During this phase, differentiation of cells proceed to give rise to the fully formed dental tissues, both mineralized (such as enamel, dentin and cementum) and unminaralized (such as pulp and periodontal ligament).

d) Morphodifferentiation

During this phase, the shape of the teeth is determined by a combination of cell proliferation and cell movement.

e) Apposition

Apposition is the deposition of the matrix of dental hard tissues, characterized by alternate periods of activity and rest.

f) Calcification

During this phase, Calcification of enamel starts by the opposition of mature enamel at the cusp tips and incisal edges of the incisor teeth, and continues from these points toward the cervical margins. Interference in any of these stages is potentially hazardous and could cause developmental defects of the teeth.

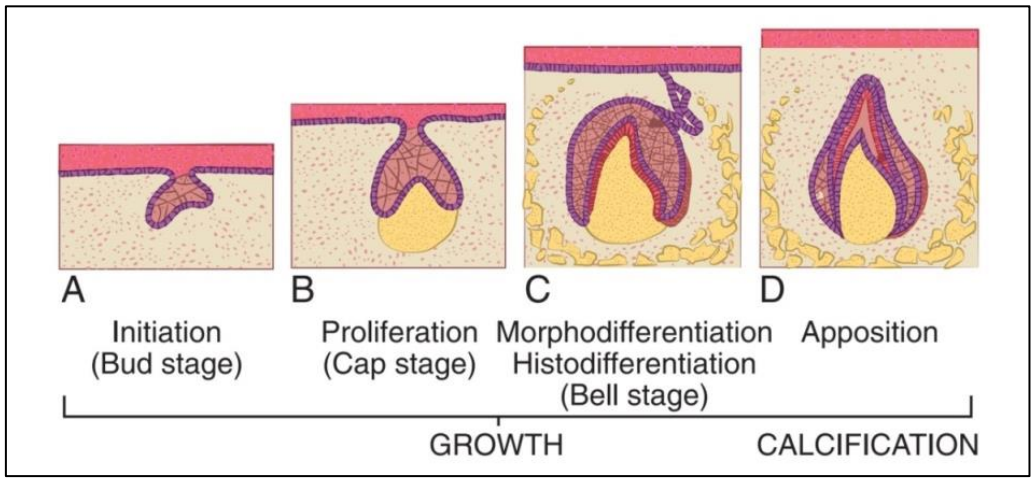

Figure 1.1: Developmental stages and histophysiology **(Nowak *et al*., 2019)**.

1.1.3 Root development

The Hertwig's epithelial root sheath (HERS) outlines the future root. The development of the roots begins after enamel and dentin formation has reached the future cementoenamel junction (CEJ). The radicular dental papilla cells differentiate under the influence of HERS cells into odontoblasts and lay down the first layer of dentin. The epithelium is moved away from the surface of the dentin allowing connective tissue cells of the dental sac to come into contact with the outer surface of the dentin which differentiate into cementoblasts, and deposit a layer of cementum. The epithelial root sheath loses its structural continuity and disintegrates. Differential growth of the epithelial diaphragm in multirooted teeth causes the division of the root trunk into two or three roots **(Kumar, 2015)**.

1.2 Conditions affecting the root of primary teeth

Severe consequences arise because of the direct or nearly direct impact of the apex of the root of a primary tooth on the crown or follicle of the developing permanent successor **(Drummond and Kilpatrick, 2015)**. Conditions affecting the root of primary teeth include; traumatic dental injuries, carious lesions with pulp involvement and ankylosis as follows **(Schuurs, 2013):-**

1.2.1 Trauma

A tooth injury is defined as damage to the tooth when excessive force is placed on it. It may be a fracture, luxation or avulsion, although a combination of injuries may occur in the tooth **(Hussien, 2016)**.

Traumatic dental injuries (TDI) of primary dentition have a global prevalence of approximately 11-47%. They have immediate and long term effects **(Tewari *et al*., 2018)**.

The type and severity of TDI of primary teeth and the age of the child (at the time of injury) have been regarded as the critical determinants of long term sequelae on permanent dentition **(Tewari *et al*., 2018)**.

The bone tissue barrier that separates the deciduous incisor from the germ of the successor permanent tooth has a thickness of less than 3mm, which may consist only of fibrous connective tissue. Due to this close relationship, trauma to the supporting tissue may be more likely to cause sequelae in the permanent successor tooth, and many of these changes can be diagnosed only when the tooth is clinically visible.

Intrusive luxation was the trauma that caused the most change, followed by concussion, subluxation, and avulsion. An intruded deciduous tooth is strongly related to damage to permanent successors, since there is a great possibility of physical contact between the traumatized tooth and the successor germ (Fig. 1.2) **(Pugliesi *et al*., 2020)**. In addition to the physical impact of the

trauma, necrosis and periapical inflammation may injure the developing tooth **(Skaare *et al*., 2015)**.

Because the children's facial skeleton is less dense, displays plasticity of the supporting tissues, and the teeth have short roots; root fracture of primary teeth is a rare injury, which if not managed properly, can cause numerous complications, including premature tooth loss and altered eruption of the permanent teeth **(Sockalingam and Khan, 2022; Spinas *et al*., 2022).**

A traumatized primary incisor should always be removed if its maintenance will jeopardize the developing tooth bud. If retained, it should be assessed regularly for clinical and radiographic signs of pulpal or periodontal complications. In intrusive luxation injuries, if the root of primary tooth is displaced palatally towards the permanent successor, the primary tooth should be extracted to minimize the possible damage to the developing permanent successor. If the root is displaced buccally, it should be left for spontaneous re-eruption. Replantation of avulsed primary incisors is not recommended because of the risk of damage to the permanent tooth bud **(Welbury *et al*., 2012)**.

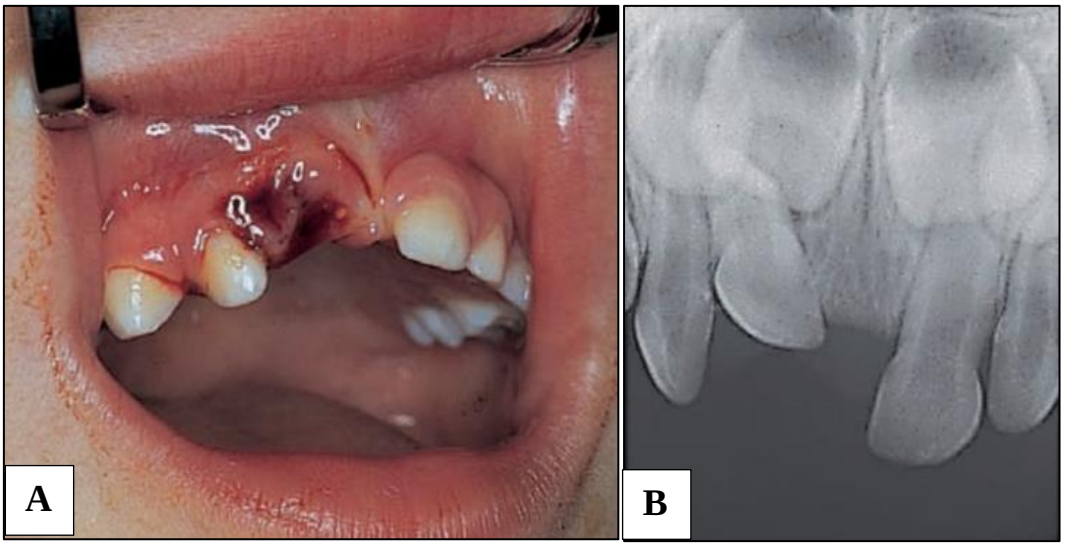

Figure 1.2: Intrusive luxation of primary incisor (A) Clinically. (B) Radiographically. **(Koch and Poulsen, 2009)**.

1.2.2 Ankylosis:

Dentoalveolar ankylosis can be defined as a condition in which the root cementum fuses with the surrounding alveolar bone. The periodontal ligament is substituted with bony tissue, causing immobility of the tooth **(Moura *et al.*, 2015)**. Many terms are used in literature to describe this condition; the most common are (submerged tooth, retentive tooth, infraocclusion and replacement root resorption) **(Patano *et al*., 2023)**.

The etiology of ankylosis remains unknown, but some factors, such as genetic predisposition, excessive masticatory force, infection, and trauma have been attributed as causes **(Moura *et al.*, 2015)**.

Lateral luxation and intrusion are in the group of traumatic injuries commonly associated with more serious complications like ankylosis. This is due to the severe damage to the surrounding tissues (periodontal ligament, neurovascular bundle) as well as to unmineralized (pre-cement) and hard tissues of the tooth (cement, dentin). Ankylosis also appears in teeth where periodontal ligament has been dried due to the long extraoral period or inappropriate treatment handling in case of avulsion injuries **(Zaleckiene *et al*., 2014)**.

In the most severe cases, ankylosis causes malocclusion, delayed eruption and morphological alterations in premolars, and a tendency of impaction of the successor permanent tooth (Fig. 1.3) **(Moura *et al.*, 2015)**. One third of cases are associated with opacities, hypoplasia and abnormal crown morphology of the permanent teeth **(Schuurs, 2013)**.

Extraction of an ankylosed primary tooth is recommended when its prolonged retention is observed to prevent ectopic eruption of the permanent successor **(Welbury *et al*., 2012; Moura *et al*., 2015)**.

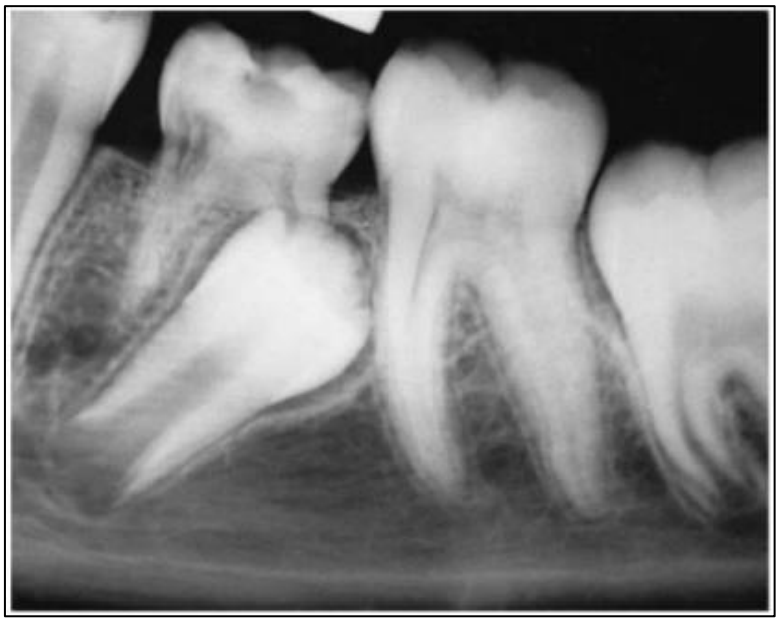

Figure 1.3: Ankylosed second primary molar **(Dean, 2021)**.

1.2.3 Carious lesions with pulp involvement

Carious lesions are more progressive in primary teeth because of the thin enamel and dentin structure, which enables the infection to spread quickly and affect the pulp tissue **(Mulia *et al.*, 2018)**. Caries extending into the pulp of primary teeth often results in necrosis of the pulp tissue and periapical lesions (Fig. 1.4) **(Wong, 2014)**:-

The consequent periapical and inter-radicular infection (via accessory canals in the furcation area in molars) endangers amelogenesis in the succedaneous tooth germ, resulting in the development of "Turner teeth" or "Turner's hypoplasia". Almost a quarter of deciduous teeth with abscesses have defective successors. Premolars are twice more prone to Turner's hypoplasia than incisors **(Schuurs, 2013)**. In a study conducted by McCormick and Filostrat in 1967, over 25% of abscessed primary teeth were associated with enamel defects, which varied from opacities to hypoplasia, in the successional permanent teeth. In extreme cases, inter-radicular infection of a primary tooth can cause arrest of the developing tooth germ **(Wong, 2014)**. Permanent tooth

deflection from the normal path of eruption, and even death of the developing tooth may occur as a result of the retention of infected primary teeth **(Dean, 2021)**.

Caries with pulp involvement presented with the largest risk of pathological primary root resorption. Thus, eruption rate can change due to caries with pulp involvement **(Mulia *et al*., 2018)**.

The severity of the infection and the developmental stage and location of the successor tooth determine the degree of damage **(Schuurs, 2013)**.

Effective pulpal therapy in the primary dentition must not only stabilize the affected primary tooth, but also create a favourable environment for normal exfoliation of the primary tooth, without harm to the developing enamel or interference with the normal eruption of its permanent successor. Where these outcomes cannot reasonably be achieved, it is appropriate to extract the affected tooth and consider alternative strategies for occlusal guidance and maintenance of arch integrity. Space maintainers can be used for this purpose **(Cameron and Widmer, 2008; Watt *et al*., 2018)**.

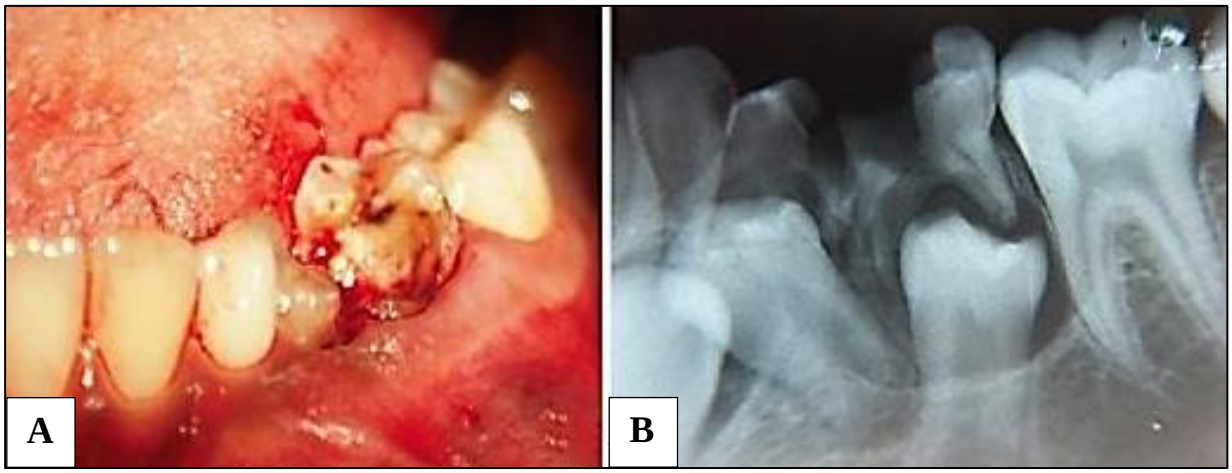

Figure 1.4: Caries with pulp involvement in lower E (A) Clinically. (B) Radiographically. **(Chalakkal *et al*., 2021).**

1.3 Consequences of primary root condition on the developing permanent successors

1.3.1 Enamel defects

Clinically, developmental enamel defects often present with problems of discoloration and aesthetics, tooth sensitivity, and susceptibility to caries, wear and erosion. Developmental enamel defects may present as enamel hypoplasia or hypomineralization as follows **(Seow, 2014)**:-

a) Enamel hypoplasia:

-Definition:-

Hypoplasia is a quantitative developmental defect caused by failure of matrix production or insufficient deposition of proteins on the outside of the developing enamel surface, whereby the normally smooth enamel surface becomes pitted or lacks in substance in large parts, it may be very thin or totally absent **(Schuurs, 2013)**.

-Etiology:-

Enamel hypoplasia can occur if the inflammation progresses to the stage of enamel apposition **(Mulia *et al*., 2018)**. Turner in 1912 first described this localized type of hypoplasia. He noted defects in the enamel of two premolars and traced the defects to apical infection of the nearest primary molar. Enamel hypoplasia resulting from local infection is called “Turner tooth” (Fig. 1.5) **(Dean, 2021)**.

Another localized type of hypoplasia is circular enamel hypoplasia, which is an extensive enamel disturbance that results in a demarcating line surrounding the crown of the injured permanent teeth visible both clinically and radiographically (Fig. 1.6) **(Sandhu *et al*., 2014)** charachterized by yellow-brown discoloration and horizontal groove that encircles the crown cervical to

the discolored areas **(Flores and Onetto, 2019)**. The circular enamel hypoplasia is a typical finding associated with intrusion or avulsion of primary teeth **(Flores and Onetto, 2019)**.

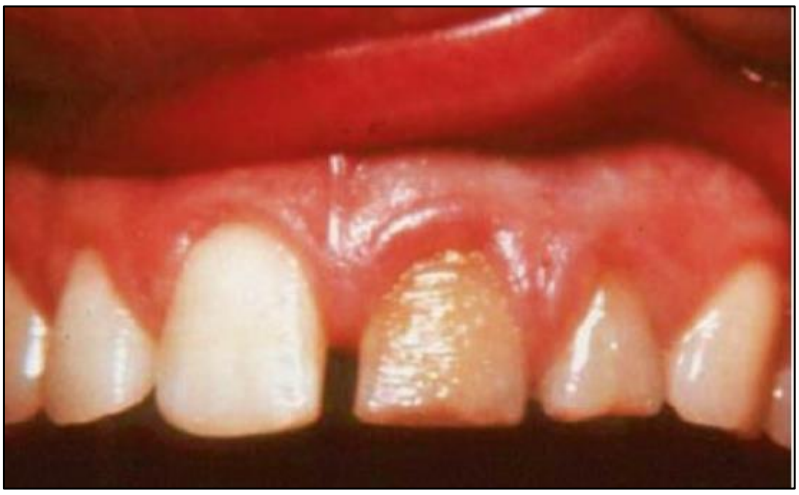

Figure 1.5: Turner's tooth **(Soxman *et al*., 2019)**.

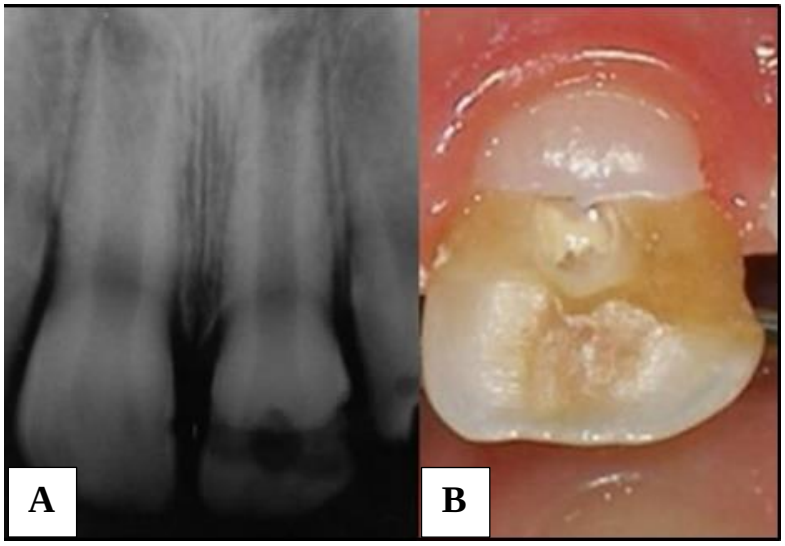

Figure 1.6: Circular enamel hypoplasia (A) Radiographically. (B) Clinically. **(Flores and Onetto, 2019)**.

b) Enamel hypomineralization:

-Definition:-

Hypocalcification presents as localised abnormalities in tooth color, called opacities (Fig. 1.7), which may be **(Schuurs, 2013)**:-

- Diffuse, non-demarcated chalky-white spots.
- Well-demarcated spots, often white, and otherwise cream, yellow or brown.

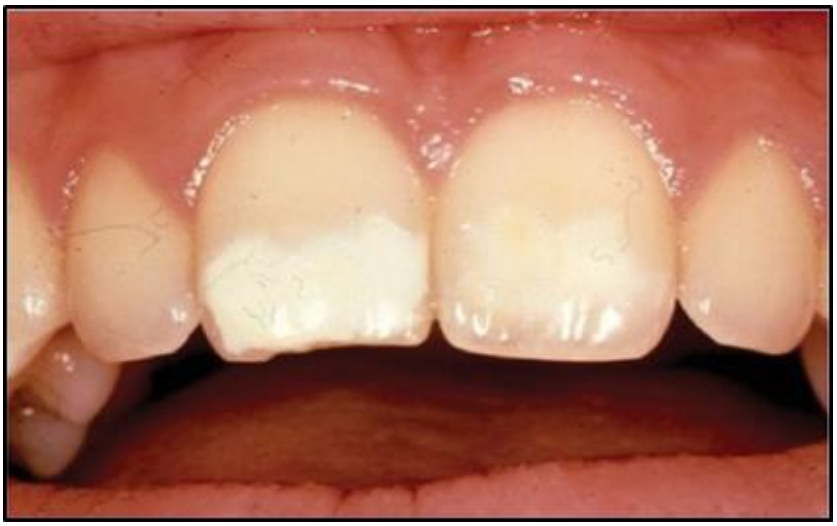

Figure 1.7: White hypomineralization **(Ansari *et al*., 2019)**.

-Etiology:-

If the inflammation from caries with pulp involvement in the primary teeth occurs during the calcification stage of the permanent teeth, changes in the microstructure of the enamel leading to changes in enamel opacity may occur **(Mulia *et al*., 2018)**.

-Management:-

Yellow-brown hypomineralization of enamel with or without hypoplasia can be managed by **(Welbury *et al*., 2012)**:-

- Acid–pumice micro–abrasion
- Composite resin restoration: localized, veneer, or crown
- Porcelain restoration: veneer or crown (anterior); fused to metal crown (posterior).

1.3.2 Crown/root dilaceration

-Definition:-

Dilaceration is an evolutionary disorder between the mineralized and non-mineralized parts of the structure of a developing permanent tooth **(Asheghi *et al*., 2022)**.

The term dilaceration describes an abrupt deviation of the long axis of the crown or root portion of the tooth (Fig. 1.8). This deviation results from the traumatic displacement of hard tissue, which has already been formed, relative to developing soft tissue **(Welbury *et al*., 2012)**.

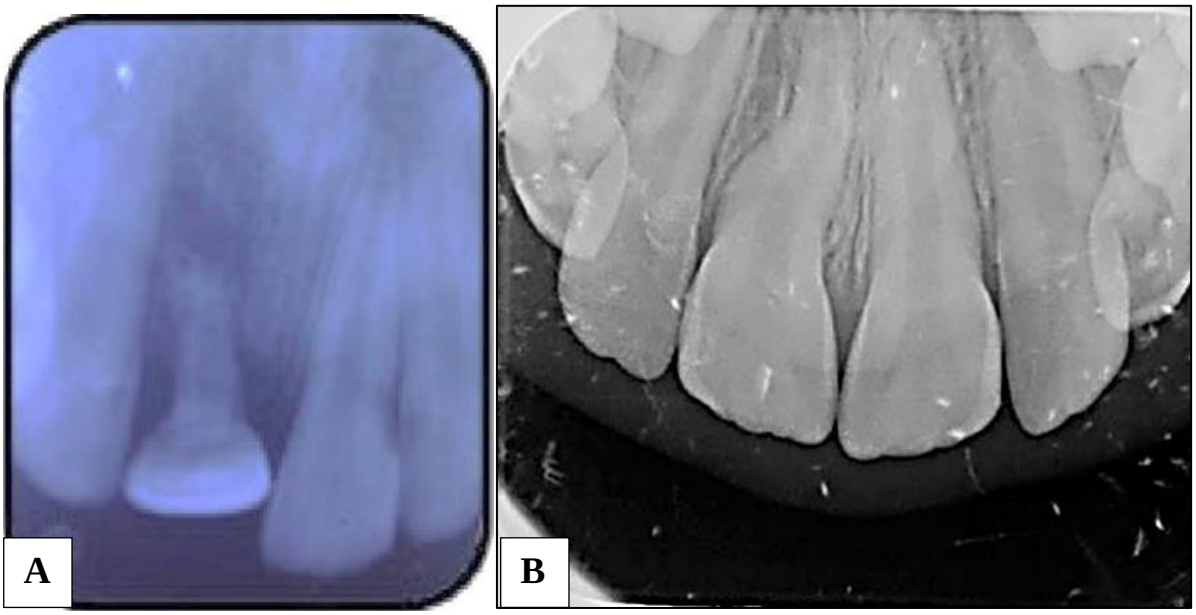

Figure 1.8: Dilaceration. (A) Crown dilaceration **(Ghimire and Rao, 2013)**.
(B) Root dilaceration **(Soxman *et al*., 2019)**.

-Etiology:-

Luxation injuries, such as intrusion and avulsion to the primary teeth, can give rise to tooth dilaceration of the permanent successor teeth **(Sockalingam and Khan, 2022)**.

-Management:-

Crown dilaceration can be managed by **(Welbury *et al*., 2012):-**

- Surgical exposure and orthodontic realignment.
- Removal of the dilacerated part of the crown.
- Temporary crown until root formation is completed.
- Semi-permanent or permanent restoration.

1.3.3 Vestibular or lateral root angulation

-Definition:-

The term angulation describes a curvature of the root resulting from a gradual change in the direction of root development, without evidence of abrupt displacement of the tooth germ during odontogenesis. This may be vestibular (i.e. labiopalatal) or lateral (i.e. mesiodistal) (Fig. 1.9) **(Welbury *et al*., 2012)**.

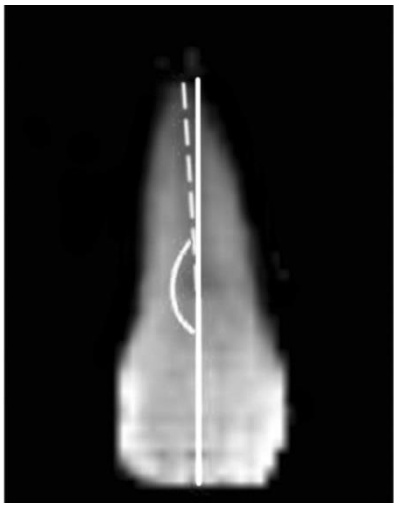

Figure 1.9: Mesiodistal root angulation of permanent incisor **(Lee *et al*., 2022)**.

-Etiology:-

The type of injury causing this malformation varied but usually intrusive luxation or exarticulation (avulsion) had occurred in the primary dentition **(Andreasen *et al*., 1971)**.

-Management:-

Combined surgical and orthodontic realignment **(Welbury *et al*., 2012)**.

1.3.4 Odontoma-like malformation

-Definition:-

Odontomas are hamartomatous developmental malformations of the dental tissues **(Maltagliati *et al*., 2020)**.

Odontomas have been classified into two types depending on their degree of morphodifferentiation; compound odontoma and complex odontoma. The

compound odontoma (Fig. 1.10) is a lesion in which all the dental tissues are represented in an orderly fashion so that there is at least superficial anatomic resemblance to teeth. In a complex odontoma (Fig. 1.11), on the other hand, although all the dental tissues are represented, they are formed in such a rudimentary fashion that there is little or no morphologic similarity to normal tooth formation **(Dean, 2021)**.

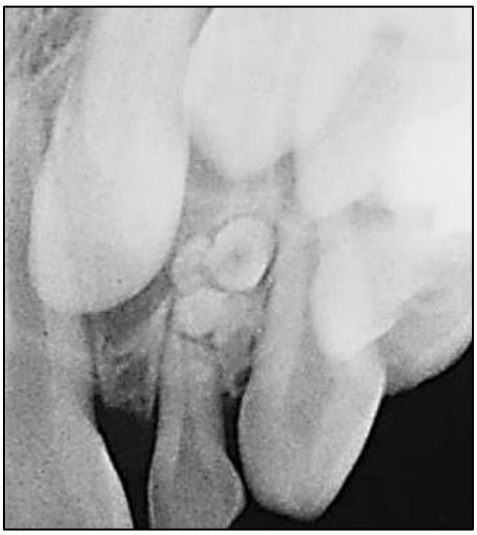

Figure 1.10: Compound odontoma **(Dean, 2021)**.

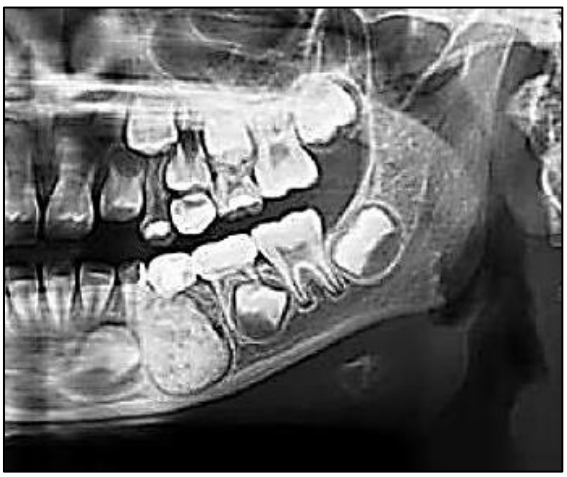

Figure 1.11: Complex odontoma **(Dean, 2021)**.

-Etiology:-

Severe trauma to the permanent tooth bud at an early stage of odontogenesis may lead to complete deformation of the tooth, causing an odontoma-like formation **(Villasenín *et al*., 2022)**.

-Management:-

Treatment consists of complete surgical excision of the lesion. The prognosis is excellent and it does not recur **(Soxman *et al*., 2019)**.

1.3.5 Bifid roots

-Definition:-

Bifid roots are supernumerary radicular structures resulting from cleavage of a regular root.

-Etiology:-

A second root on a maxillary central incisor (with dilaceration) was attributed to trauma to the deciduous predecessor (Fig. 1.12) **(Schuurs, 2013)**.

Figure 1.12: Upper central incisor with bifid root **(Schuurs, 2013)**.

-Management:-

Bifid roots do not require treatment **(Schuurs, 2013)**.

1.3.6 Partial or complete arrest of root formation

-Etiology:-

Disturbances in root formation of developing permanent teeth (Fig. 1.13) occur more commonly when trauma affects the primary teeth of children more than 4 years old, at a time when the crown of the successor permanent tooth is in its final stage of formation and the root is in its initial development **(Subramaniam *et al*., 2013)**.

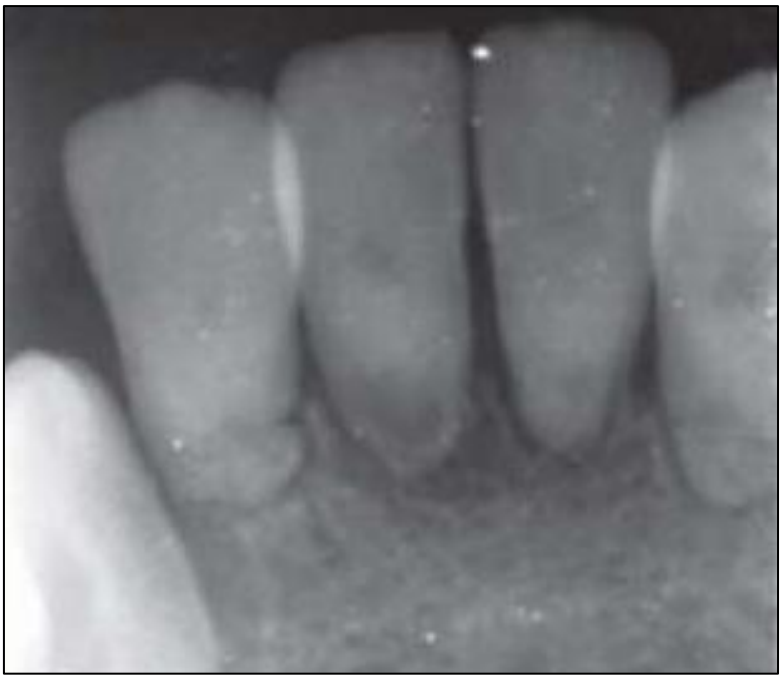

Figure 1.13: Arrest of root formation **(Subramaniam *et al*., 2013)**.

-Management:-

Permanent mandibular incisors exhibiting mobility due to arrested root development were successfully managed with immediate stabilization using resin-reinforced fiber splint. The natural teeth were retained in position until a permanent replacement could be done for restoration of function, periodontal health and esthetics **(Subramaniam *et al*., 2013)**.

1.3.7 Disturbance in eruption

-Etiology:-

Alterations in eruption were much less common than enamel lesions **(Villasenín *et al*., 2022)**. In some instances, the traumatized deciduous incisor might become ankylosed or delayed in its root resorption. This leads to the overretention of the deciduous tooth (Fig. 1.14) and disruption in the eruption of its successor **(Peedikayil, 2011)**. Eruption disturbances may involve delay because of thickening of connective tissue over a permanent tooth germ (Fig. 1.15) or ectopic eruption due to lack of eruptive guidance, and impaction in teeth with malformations of crown or root **(Welbury *et al*., 2012)**.

Eruption rate can also change due to caries with pulp involvement. Root resorption that occurs as a result of caries with pulp involvement causes damage to the bones, which quickens the rate of resorption. Acceleration of eruption occurs if there is extensive alveolar bone damage due to chronic inflammation originating from the primary teeth **(Mulia *et al*., 2018)**.

Cystic transformation of a non-vital deciduous incisors (Fig. 1.16) might also cause delay in the eruption of the permanent successor **(Peedikayil, 2011)**.

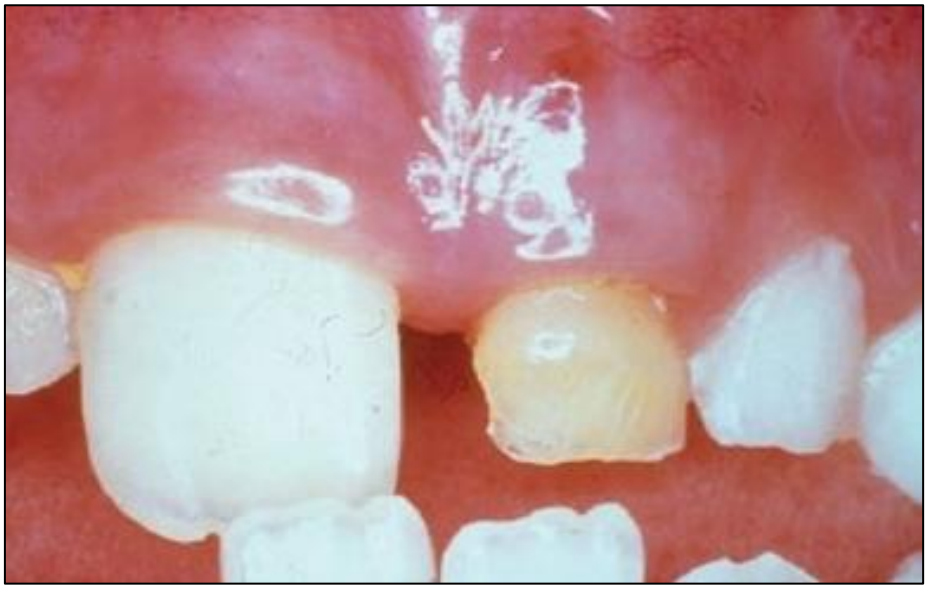

Figure 1.14: Overretention of maxillary left central incisor **(Ansari *et al*., 2019)**.

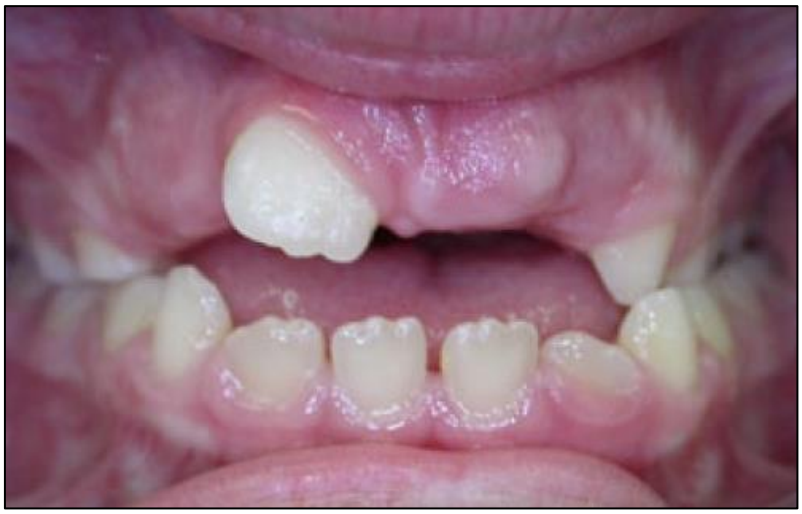

Figure 1.15: Delay in eruption of the left maxillary central incisor **(Holan and Needleman, 2014)**.

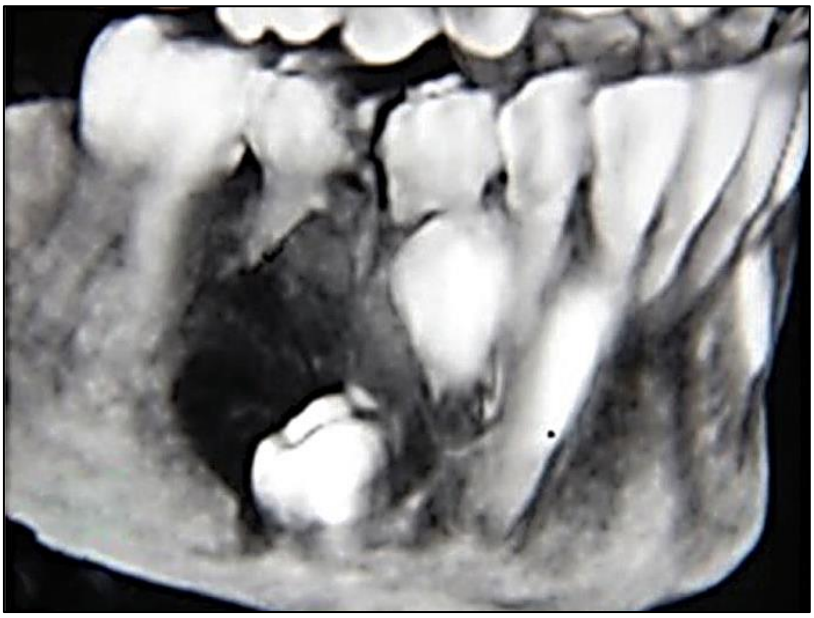

Figure 1.16: A large well defined cystic lesion in relation to lower E **(Chalakkal *et al.*, 2021)**.

-Management:-

In case of delay eruption of permanent successors, surgical exposure and orthodontic realignment is recommended **(Welbury *et al.*, 2012)**.

Chapter Two: Conclusion

Traumatic dental injury in primary teeth (especially intrusive luxation), ankylosis and caries with pulp involvement are risk factors for the development of different sequelae to permanent successors. Thus, regular follow-up and radiographs are recommended in cases of intrusion injuries in children 1-3 years of age to allow early detection and management of possible developmental disturbances.

Also, decayed primary teeth must be followed-up by both radiographic and clinical examinations, in order to verify the extension of the lesion, as they develop in the primary dentition, usually without presenting relevant clinical symptoms.

There is a need for awareness among parents and education of primary health givers concerning the preservation of primary teeth and their importance for the normal development of permanent teeth as parents do not know the value of deciduous teeth as they think that it’s going to shed and be replaced by new permanent teeth.

References

(A)

- Abbott, P.V. and Lin, S. (2022) Tooth resorption—part 2: A clinical classification. *Dental Traumatology*, 38(4), 267-285.
- Andreasen, J.O., Sundström, B. and Ravn, J.J. (1971) The effect of traumatic injuries to primary teeth on their permanent successors: I. A clinical and histologic study of 117 injured permanent teeth. *European Journal of Oral Sciences*, *79*(3), 219-283.
- Ansari, G., Golpayegani, M.V. and Welbury, R. (2019) *Atlas of pediatric oral and dental developmental anomalies*. John Wiley & Sons, 2-16
- Asheghi, B., Sahebi, S., Zangooei Booshehri, M. and Sheybanifard, F. (2022) Evaluation of Root Dilaceration by Cone Beam Computed Tomography in Iranian South Subpopulation: Permanent Molars. *Journal of Dentistry*, *23*, 369-376.

(C)

- Chalakkal, P., De Souza, N., De Ataide, I.D., Akkara, F. and Chandran, R. (2021) The resistance of succedaneous teeth to periapical infection: A series of seven cases. *Contemporary Clinical Dentistry*, 12(1), 88.
- Villasenín, L.C., Muñoz, C.S., Silva, A.P., Hernández, A.V., Pascual, A.P. and Ruiz, A.J.O. (2022) Developmental dental defects in permanent teeth resulting from trauma in primary dentition: A systematic review. *International Journal of Environmental Research and Public Health*, 19(2), 754.
- Cameron, A.C. and Widmer, R.P. (2008) *Handbook of Pediatric Dentistry 3rd Edition*. Mosby Elsevier, 95.

(D)

- De Moura, M.S., Pontes, A.S., Brito, M.H.S.F., De Deus Moura, L., De Deus Moura De Lima, M., De Melo, S. and Henrique, A. (2015) Restorative management of severely ankylosed primary molars. *Journal of Dentistry for Children*, 82(1), 41-46.
- Dean, J.A. (2021) *McDonald and Avery's dentistry for the child and adolescent 11th edition*. Elsevier Health Sciences, 4-412.
- Drummond, B.K. and Kilpatrick, N. (2015) *Planning and Care for Children and Adolescents with Dental Enamel Defects*. Springer-Verlag Berlin An, 2-21.

(F)

- Flores, M.T. and Onetto, J.E. (2019) How does orofacial trauma in children affect the developing dentition? Long-term treatment and associated complications. *Journal of endodontics*, *45*(12), S1-S12.

(G)

- Ghanim, A., Elfrink, M., Weerheijm, k., Mariño, R., Manton D. (2015) A practical method for use in epidemiological studies on enamel hypomineralisation. *European archives of paediatric dentistry*, 16, 235-246.
- Ghimire, N. and Rao, A. (2013) Crown dilaceration. *Health Renaissance*, 11 (1), 86-88.
- Goswami, M., Rahman, B. and Singh, S. (2020) Outcomes of luxation injuries to primary teeth-a systematic review. *Journal of oral biology and craniofacial research*, *10*(2), 227-232.

(H)

- Holan, G. and Needleman, H.L. (2014) Premature loss of primary anterior teeth due to trauma–potential short-and long-term sequelae. *Dental Traumatology*, *30*(2), 100-106.
- Holan, G., Yodko, E. and Sheinvald-Shusterman, K. (2015) The association between traumatic dental injuries and atypical external root resorption in maxillary primary incisors. *Dental Traumatology*, *31*(1), 35-41.
- Hussien, A.A. (2016) Traumatic dental injuries among 6–13–year-old-school children in Tikrit City. *Mustansiria Dent J*, *13*(1), 46-51.

(K)

- Koch, G. and Poulsen, S. (2009) *Pediatric dentistry: a clinical approach 2nd edition*. John Wiley & Sons, 241-267.
- Kumar, G.S., 2015. *Orban's Oral Histology & Embryology 14th edition*. Elsevier Health Sciences, 25-36.

(L)

- Lee, K.H., Choi, D.S., Jang, I. and Cha, B.K. (2022) Crown-root angulations of the maxillary anterior teeth according to malocclusions: A cone-beam computed tomography study in Korean population. *Korean Journal of Orthodontics*, *52*(6), 432-438.

(M)

- Maltagliati, A., Ugolini, A., Crippa, R., Farronato, M., Paglia, M., Blasi, S. and Angiero, F. (2020) Complex odontoma at the upper right maxilla: Surgical management and histomorphological profile. *European Journal of Paediatric Dentistry*, *21*(3), 199-202.

- Manohar, J. and Mani, G. (2017) Knowledge and attitude of parents regarding children's primary teeth & their willingness for treatment. *Journal of Pharmaceutical Sciences and Research*, 9(2), 194.
- Masumo, R., Bårdsen, A., and Astrøm, A.N. (2013) Developmental defects of enamel in primary teeth and association with early life course events: a study of 6-36 month old children in Manyara, Tanzania. *BMC Oral Health*, 13: 21.
- Muhamad, A.H., Nezar, W., Azzaldeen, A. and Hanali, A.S. (2015) Anterior dental esthetics in primary teeth. *International Journal of Public Health Research*, 3(1), 25-36.
- Mulia, D.P., Indiarti, I.S. and Budiarjo, S.B. (2018) August. Effect of root resorption of primary teeth on the development of its permanent successors: An evaluation of panoramic radiographs in 7–8 year-old boys. *In Journal of Physics: Conference Series*, 1073, 3, 032015.

(N)

- Nanci, A. (2018) *Ten Cate's Oral Histology: development, structure, and function 9th edition*. Elsevier Health Sciences, 79-223.
- Nowak, A., Christensen, J.R., Mabry, T.R., Townsend, J.A. and Wells, M.H. eds. (2019) *Pediatric Dentistry: infancy through adolescence 6th edition.* Elsevier Health Sciences, 187-452.

(P)

- Patano, A., Inchingolo, A.M., Laudadio, C., Azzollini, D., Marinelli, G., Ceci, S., Latini, G., Rapone, B., Inchingolo, A.D., Mancini, A., Inchingolo, F., Di Venere, D., Tartaglia, G.M., Dipalma, G. and Malcangi, G. (2023)

Therapeutic strategies of primary molar infraocclusion: A systematic review. *Children*, 10(3), 582.

- Peedikayil, F.C. (2011) Delayed tooth eruption. *e-Journal of Dentistry*, *1*(4).
- Pugliesi, D.M.C., Araujo, L.D.C., Junior, V.E.S. and Cunha, R.F. (2020) Clinical and radiographic analysis of traumatized primary teeth and permanent successors: longitudinal study. *Journal of Indian Society of Pedodontics and Preventive Dentistry*, *38*(3), 232-237.

(R)

- Rajkumar, K. and Ramya, R. (2017) *Textbook of Oral Anatomy, Physiology, Histology and Tooth Morphology 2nd edition*. Wolters kluwer india Pvt Ltd, 613-614.

(S)

- Saleem, A.E., Jabur, S.F. and Al-Assadi, A.H. (2010) Traumatic injuries to the incisors among patients attending pedodontic clinic of Baghdad dental teaching hospital. *Journal of baghdad college of dentistry*, *22*(3).
- Sandhu, M., Gulia, S., Nagpal, M. and Sachdev, V. (2014) Circular enamel hypoplasia: a rare enamel developmental disturbance in permanent teeth. *Journal of Clinical and Diagnostic Research: JCDR*, *8*(8), ZD39.
- Schuurs, A. (2013) *Pathology of the hard dental tissues*. John Wiley & Sons, 79.
- Seow, W.K. (2014) Developmental defects of enamel and dentine: challenges for basic science research and clinical management. *Australian dental journal*, *59*, 143-154.

- Silva, D.R., Shahinian, A.L. (2022) Odontoma malformation and disturbances of eruption subsequent to traumatic dental injuries: A literature review and a case report. *Dental Traumatology*, 38(2), 98-104.
- Skaare, A.B., Aas, A.L.M. and Wang, N.J. (2015) Enamel defects on permanent successors following luxation injuries to primary teeth and carers' experiences. *International Journal of Paediatric Dentistry*, *25*(3), 221-228.
- Sockalingam, S.N.M. and Khan, K.A.M. (2022) Multidisciplinary Management of A Nasally Displaced Dilacerated Tooth Following Early Childhood Dental Trauma: A Case Report. *European Journal of Dental and Oral Health*, *3*(1), 9-13.
- Soxman, J.A., Wunsch, P.B. and Haberland, C.M. (2019) *Anomalies of the Developing Dentition*. Springer International Publishing, 84-102.
- Spinas, E., Di Giorgio, G., Murgia, M.S., Garau, V., Pinna, M. and Zerman, N. (2022) Root fractures in the primary teeth and their management: a scoping review. *Dentistry Journal*, *10*(5), 74.
- Subramaniam, P., Gupta, M. and Gona, H. (2013) Arrest of root formation in relation to permanent mandibular incisors: a rare case report. *The Journal of Contemporary Dental Practice*, 14 (3), 552.

(T)

- Tewari, N., Mathur, V.P., Singh, N., Singh, S. and Pandey, R.K. (2018) Long-term effects of traumatic dental injuries of primary dentition on permanent successors: A retrospective study of 596 teeth. *Dental Traumatology*, 34(2), 129-134.

(W)

- Watt, E., Ahmad, A., Adamji, R., Katsimbali, A., Ashley, P. and Noar, J. (2018) Space maintainers in the primary and mixed dentition–a clinical guide. *British Dental Journal*, *225*(4), 293-298.
- Welbury, R., Duggal, M.S. and Hosey, M.T. (2012) *Pediatric dentistry 4th edition.* Oxford University Press, 12-13.
- Wong, H.M. (2014) Aetiological factors for developmental defects of enamel. *Austin journal of anatomy*, 1(1):1003.

(Z)

- Zaleckiene, V., Peciuliene, V., Brukiene, V. and Drukteinis, S. (2014) Traumatic dental injuries: etiology, prevalence and possible outcomes. *Stomatologija*, *16*(1), 7-14.