Republic Of Iraq
Ministry Of High Education
And Scientific Research
University Of Baghdad
College Of Dentistry

Taurodontism Teeth: A Literature Review

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

By

Tiba Haider Muneer

Supervised by

Dr. Maryeem Hameed

B.D.S., M.Sc. (Oral Histology)

2022 A.D. 1443 A.H.

Certification Of Supervisor

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

Supervisor's name:
Dr. Maryeem Hameed

B.D.S., M.Sc. (Oral Histology)

Date:

Acknowledgment

First and foremost, I would like to thank **Allah** Almighty for giving me the strength, knowledge, willingness and patience to complete this work.

My deepest gratitude and sincere appreciation to my supervisor **Dr. Maryeem Hameed** who supported me throughout this project. Thank you for your cooperation, kind advice, care, continuous motivation and invaluable guidance during the entire research period.

Finally, I would like to express grateful thanks to **my family** and **friends** for their love, paience, care and prayers for me.

List Of Contents

List Of Figures

List Of Tables

List Of Abbreviations

Abbreviations	Phases
HERS	Hertwig's epithelial root sheath
EDA	Ectodysplasin A
CEJ	Cemento-enamel junction
TI	Taurodontism index
CB	Crown- body length
R	Root length
PUI	Passive ultrasonic irrigation
CBCT	Cone beam computed tomography
MTA	Mineral trioxide aggregate
CEM	Calcium enriched mixture
Wnt	Wingless/Integrated
EDA	Ectodysplasin A
EDAR	Ectodysplasin A receptor

Introduction

The development of tooth is a complex process controlled by various factors. Therefore this process may be disturbed by defect in genetic control, nutritional or hormonal imbalances, infections or disturbances in local environment where the tooth development occurs, resulting in various anomalies. Developmental anomalies of teeth may be grouped into those affecting number, size, shape, structure, location, etc. One of the most important abnormalities in tooth morphology is taurodontism. Witkop defined taurodontism as teeth with large pulp chambers in which the bifurcation or trifurcation are displaced apically, so that the chamber has greater apical-occlusal height than in normal teeth and lacks the constriction at the level of cemento-enamel junction (CEJ). The distance from the trifurcation or bifurcation of the root to the CEJ is greater than the occlusal-cervical distance . It is characterized by vertically elongated pulp chambers, apical displacement of the pulpal floor, and bifurcation or trifurcation of the roots.

Taurodontism was first described in 1908 by Gorjanovic-Kramberger a 70,000-year old pre-Neanderthal fossil, discovered in Katrina, Croatia. The first report of taurodontism in modern man's dentition was published in 1909 by Pickerill, who used the term "radicular dentinoma" to describe the condition.The term "taurodontism" was first specified by Sir Arthur Keith in 1913. The origin of this term is from Greek "Taurus" which means "Bull" and "odontoid" which means "Tooth", because of the morphological resemblance of affected tooth to the tooth of hoofed animal, especially bulls. Keith (1913) suggested that taurodontism is a distinctive characteristic of the Neanderthals. He pointed out molars of the modern dentitions, which he called 'cynodont' (doglike teeth which have relatively small pulp chambers, set low in the crown with a constriction in outline form of the chambers at about the CEJ) could not have been evolved from such taurodont teeth.

It is recognized as a clinical variant for almost a century. It has been found in the dentition of modern day races. It has particular importance in the study of phylogenetic relationships and population affinities.

Previously, taurodontism was related to syndromes such as Klinefelter's and Down's. Today it is considered as an anatomic variance that could occur in a normal population.

CHAPTER ONE
REVIEW OF LITERATUR

1.1 Etiology and pathogenesis

Theories regarding the etiology of taurodontism have been many. It has been suggested that the anomaly represents a primitive pattern, a mutation, a specialized or retrograde character, an atavistic feature, an X-linked trait, familial or an autosomal dominant trait. Taurodontism appears most frequently as an isolated anomaly, but it has also been associated with several developmental syndromes and anomalies **(Manjunatha and Kovvuru, 2010).** It has been found to occur as a part Down's syndrome, and many other less common syndromes. Taurodontism has also been reported associated with Dwarfism, Cleft palate and other dental anomalies such as hypodontia, microdontia and dens invaginatus, amelogenesis imperfecta, ectodermal dysplasia etc. Taurodontism has also been reported to present with other rare syndromes such as Smith-Magenis syndrome, Williams syndrome, McCune-Albright syndrome and Van der Woude syndrome, Mohr syndrome, and Kline Felter's syndrome **(Hemalatha and Attavar, 2015**). Many of these disorders have oral manifestations, which can be detected on dental radiographs as alterations in the morphology or chemical composition of the teeth; thus, dentists may be the first to detect them. **(Jafarzadeh *et al*., 2008).**

In general, patient with more severe forms of the triat (meso or hyper) are more likely to have X-chromosomal aneuploidy. The prevalence of taurodontism increases as the number of X-chromosomes increases and also indicate that expression of the triat and the number of X-chromosomes may be positively correlated **(Jayashankara *et al*., 2013).**

Theories concerning the pathogenesis of taurodontism root formation are also diverse:

a) An unusual developmental pattern

b) A delay in calcification of the pulp chamber floor

c) An odontoblastic deficiency

d) A delayed or incomplete union of the horizontal flaps of the epithelial diaphragm

e) An alteration in Hertwig's epithelial root sheath, with an apparent failure of the epithelial diaphragm to invaginate at the normal horizontal levels, which is the most common accepted theory. Hertwig's epithelial root sheath (HERS) is formed from the disappearance of the stellate reticulum within the enamel organ, once enamel has formed, and the fusion of the inner and outer enamel epithelia to form the cervical loop. As HERS extends downward, it encloses the dental papilla, thus creating the outline of the root as shown in the *figure (1-1)*. HERS then stimulates the surrounding dental papilla mesenchyme to differentiate into odontoblasts and secrete the dentin of the root. The number of roots of a tooth is determined by the subdivision, or lack thereof, of HERS **(Chetty *et al*., 2021; Hemalatha and Attavar, 2015**; **Bains *et al*., 2010).**

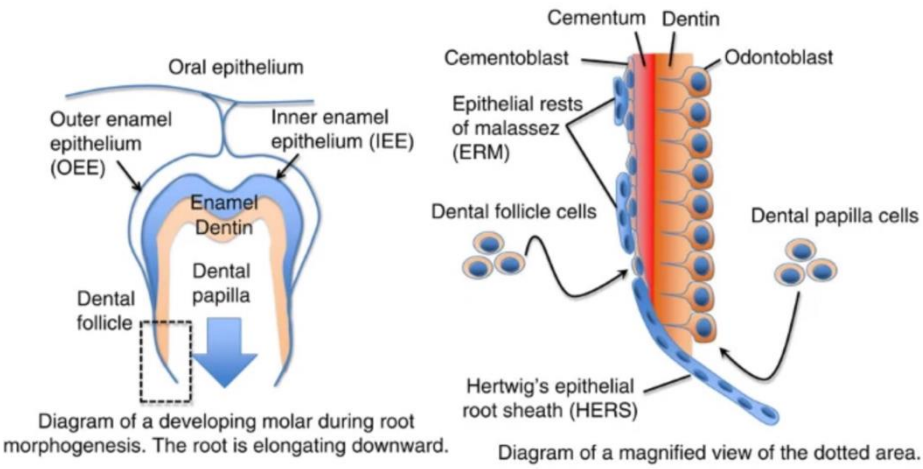

Fig (1-1): Shown is the diagram of a developing molar during root morphogenesis **(Ono *et al*., 2016).**

Several transcription and growth factors are expressed by HERS. A delay or failure of HERS to invaginate into the mesenchyme results in the apical displacement of the root furcation and subsequently in the development of taurodontism.

The ectodysplasin A (EDA)/EDA receptor signaling pathway plays a critical role in tooth development and in particular, in root development. The component of the Eda pathway, Edar, is expressed during root development with a very specific expression in the developing HERS as in the

figure (1-2). Loss of Eda or Edar leads to a taurodont phenotype, with the upper second molars being the most sensitive to loss of this pathway.

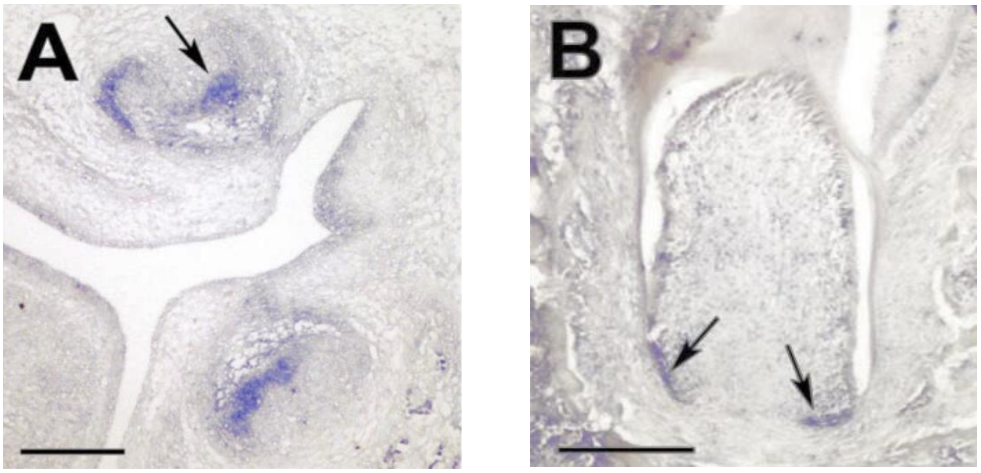

Fig (1-2): Edar is expressed in Hertwig's epithelial root sheath (HERS) during root development. In situ hybridization for Edar, with positive stain in blue. **(A)** late cap stage tooth. Expression of Edar is observed in the dental epithelium, in the enamel knot (arrow), and spreading out across the inner dental epithelium, particularly on the lingual side of the tooth. **(B)** At postnatal day 9, Edar is expressed in the HERS (arrows) at the apical end of the tooth **(Fons Romero *et al*., 2017).**

As Edar was expressed in the HERS, this suggests another signaling factor produced by the HERS was altered in the absence of active Eda signaling. One candidate could be a member of Wnt signaling pathway,a taurodont phenotype is observed in patients and mice with mutations in Wnt10a, and loss of Wnt10a leads to defects in cusp pattern and hypodontia, mirroring many aspects of the Eda pathway mutant phenotype **(Fons Romero *et al*., 2017).**

Wnt signaling has a crucial role in several stages of tooth development. Wnt signaling activities are observed in the dental epithelium and the dental mesenchyme starting from the embryonic stage. Postnatally, an optimal level of Wnt signaling activities is required for normal tooth root formation and periodontal tissue formation **(Tokavanich *et al*., 2021).**

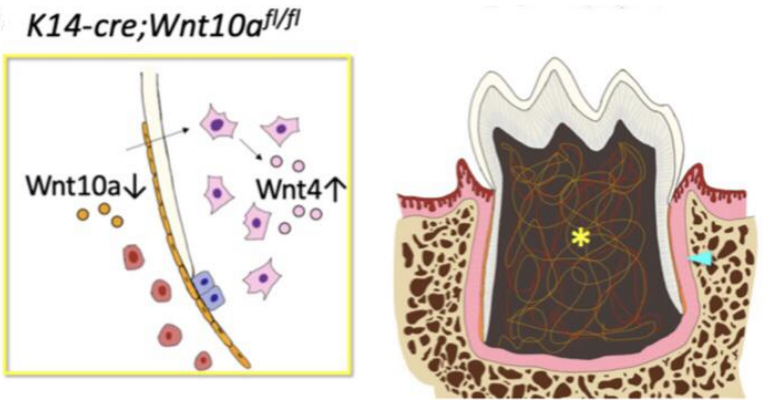

Fig (1-3): Loss of Wnt signaling in epithelial cells phenotype. **Yellow box:** Deletion of Wnt10a in HERS, increase Wnt4 expression in Dental papilla, **yellow asterisk:** Lack of pulpal floor chamber, **Blue arrowhead:** Short and thin root dentin **(Tokavanich *et al.*, 2021).**

1.2 Diagnosis and classification

Clinically, taurodont teeth cannot be diagnosed because the CEJ and roots of a taurodonttooth lie below the alveolar margin, Therefore, the diagnosis of taurodontism is usually made from diagnostic radiographs **(Azzaldeen *et al.*, 2016)**

In 1928 Shaw classified this condition as hypotaurodontism, mesotaurodontism and hypertaurodontismbased on the relative displacement of the floor of the pulp chamber *table (1-1)*. This subjective, arbitrary classification led normal teeth to be misdiagnosed as taurodontism *figure (1-4)* **(Dineshshankar *et al.*, 2014).**

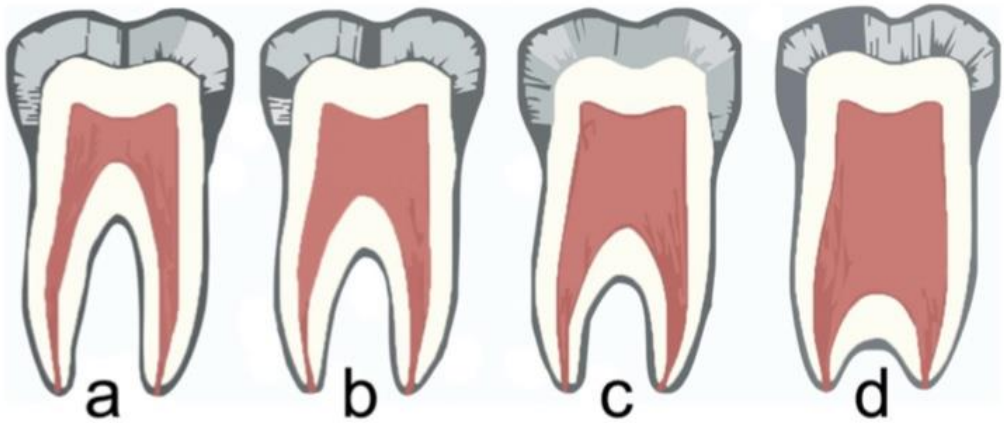

Fig (1-4): Diagrammatic representations of taurodontic teeth: **(A)** Normal molar, **(B)** hypotaurodintism, **(C)** mesotaurodontism, **(D)** hypertaurodontism **(Chetty *et al*., 2021).**

Table (1-1): Taurodontism Classification **(Azzaldeen *et al*., 2016).**

Category	Degree	Description
Hypotaurodontism	Mild	Moderate enlargement of the pulp chamber at the expense of the roots.
Mesotaurodontism	Moderate	pulp is quite large and the roots short but still separate.
Hypertaurodontism	Severe	prismatic or cylindrical forms where the pulp chamber nearly reaches the apex and then breaks up into 2 or 4 channels.

This subjective, arbitrary classification commonly led to a misdiagnosis of taurodontism. Although preferred, it is not regarded as an objective analysis **(Jafarzadeh *et al*., 2008).** It is important to diagnose taurodontism by means of metric analysis rather than just depending on a visual radiographic assessment which is considered opinionated .Taurodontism may be misdiagnosed in teeth that exhibit attrition and wear-induced secondary dentine deposition in the pulp chambers. Caution should thus be exercised when interpreting taurodontism in severe cases of attrition **(Azzaldeen *et al*., 2016).**

In 1966, keene related the height of the pulp chamber to the length of the longest root.

Cynodont: index value of 0–24.9%

Hypo-T: index value of 25–49.9%

Meso-T: index value of 50–74.9%

Hyper-T: index value of 75–100% **(Hemalatha and Attavar, 2015).**

The use of keene index has disadvantage noted was the use of landmarks that are considered biologically changeable structures, as the pulp chamber undergoes changes with aging and the root length is subjected to change in length, as in external resorption **(Azzaldeen *et al*., 2016).**

A biometric study conducted by Blumberg and colleagues in 1971 used five variables to diagnose taurodontism, without specific reference to any classification as shown in the *figure (1-5).* The author was of the impression that taurodontism is a continuous anomaly and therefore cannot be placed into strict categories.These variables are:

Variable 1: Mesio-distal distance between contact points of the crown.

Variable 2: Mesio-distal diameter taken at the level of the cement-enamel junction.

Variable 3: Perpendicular distance from baseline to highest point on pulp chamber floor.

Variable 4: Perpendicular distance from baseline to apex of longest root.

Variable 5: Perpendicular distance from baseline to lowest point on pulp chamber roof **(Benzahya, 2015).**

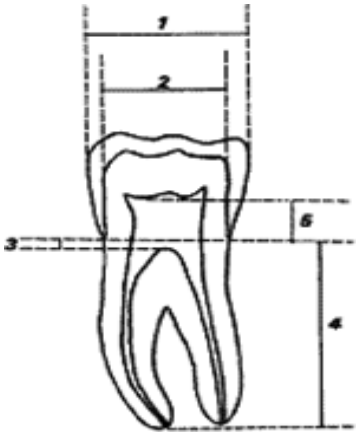

Fig (1-5): Showing Blumberg variables of taurodontism classification **(Jafarzadeh *et al*., 2008).**

In 1977, Feichfnger and Rossiwall found that the distance from the bifurcation or trifurcation of the root to the cemento-enamel junction should be greater than the occluso-cervical distance for a taurodontic tooth **(Bains *et al*., 2010).**

Though, there are many classification systems to determine the severity of taurodontism, Shifman and Chanannel in 1978 proposed a new classification and is the widely used system until now **(Dineshshankar *et al*., 2014).** Shifman and Chanannel developed a radiological evaluation system for taurodontism by objective measurements and variables, and their anatomical parameters are presented schematically in *Figure (1-6).*

The measurements include two variables: ***variable 1*** is defined as the hight of pulp chamber, between the lowest point of the roof and the highest point of floor, and ***variable 2*** is the distance between the lowest point of the roof of pulp chamber and apex of longest root.

They also developed 'taurodont index' (TI) that is related to hight of pulp chamber and length of longest root, and it is calculated as the ratio of two variables: TI= variable1/variable 2x100 Manifestations of the taurodontism is expressed in order of increased severity, according to shipman and chanannel classification of the value of TI, *hypotaurodontism*(TI value 20-30), *mesotaurodontism*(TI value 30-40), and *hypertarodontism* (TI value 40-70) **(Einy *et al*., 2022).**

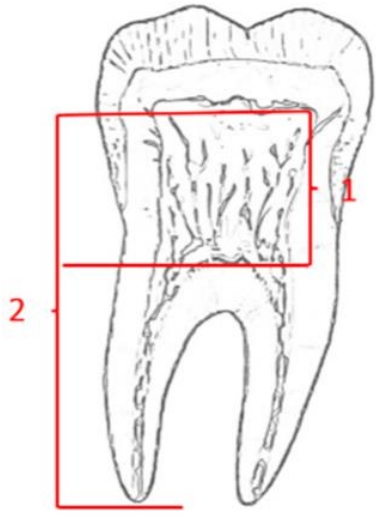

Fig (1-6): Taurodontism variables by Shifman and Chanannel 1978 **(Einy *et al*., 2022).**

In 1989, The biometric technique advised by Seow and Lai was employed to establish the diagnosis of taurodontism on panoramic radiographs, by

determining the crown-body length (CB) and root length (R) ratio. Based on this ratio, normal teeth (Cynodont) had a CB: R ratio<1.10, whereas the teeth which had a ratio between 1.10-1.29 were considered hypotaurodontic. Mesotaurodont teeth had a ratio between 1.30 and 2.00, and lastly teeth with ratio>2.0 were considered hypertaurodontic as shown in the *figure below* **(Benzahya, 2015; Azzaldeen *et al*., 2016).**

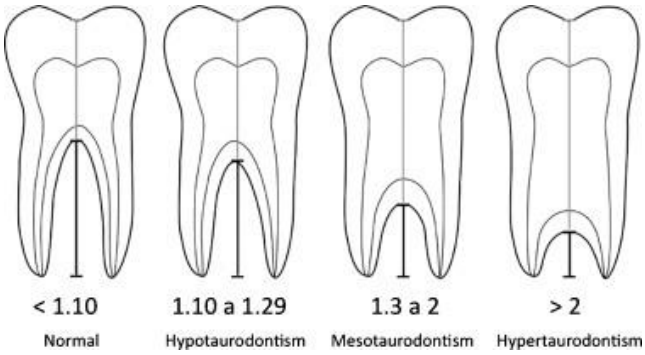

Fig (1-7): Classification of taurodontism according to crown body-root ratio **(Gomes *et al.*, 2012).**

In addition to all these methods, Tulensalo and colleagues in 1989 examined a simple method of assessing taurodontism using panoramic radiographs by measuring the distance between the baseline (a line connecting the mesial and distal points of the CEJ) and the highest point of the floor of the pulp chamber. A tooth was diagnosed as taurodontic when that distance reached or exceeded 3.5 mm. They concluded that this technique is reliable in epidemiology investigations for assessing taurodontism in a developing dentition **(Benzahya, 2015; Jafarzadeh *et al*., 2008).**

1.3 Clinical and radiographical feature

Taurodontism affects molars and premolars in both primary and permanent dentitions. It may affect a single tooth or multiple teeth, either unilaterally or bilaterally as in the *figure (1-8)*. The teeth themselves have no remarkable or unusual morphologic clinical characteristics **(Gomes *et al*., 2012).**

Radiographically, The unusual nature of this condition is best visualized on the radiograph. Involved teeth frequently tend to be rectangular in shape rather than taper toward the roots. The pulp chamber is extremely large with much greater apicoocclusal height than normal. In addition, the pulp lacks the usual constriction at the cervix of the tooth and the roots are exceedingly short. The bifurcation or trifurcation may be only a few millimeters above the apices of the roots. This radiographic picture is quite striking and characteristic

A trait which was missed in some of the radiographs on clinical examination, was diagnosed by metric analysis. It is therefore, necessary from a clinical point of view, to diagnose even the mildest form of taurodontism by using metric analysis rather than just relying on a visual radiographic assessment, as its occurrence is a complicating factor for an endodontic treatment and a risk factor for orthodontic therapy. Moreover, it may also be beneficial in the possible identification of other associatedmedical condition **(HegDe *et al*., 2013; Sivapathasundharam, 2020).**

Fig (1-8): OPG of the patient showing multiple bilateral taurodontic teeth in maxillary and mandibular arch **(Bharath *et al*., 2015).** Eeffect both primary and permanent dentitions.

1.4 Differential diagnosis

Metabolic conditions such as Pseudo hypoparthyroidism, hypophosphatasia, and hypophosphatemic vitamin D-resistant and dependent rickets, the pulp chamber may be enlarged but the teeth are of relatively normal form. Early stages of dentinogenesis imperfecta, where the appearance may resemble the large pulp chambers. Moreover, the developing molars may appear similar to taurodonts; however, an identification of wide apical foramina and incompletely formed roots may also be considered **(ML and Bhayya., 2018).**

1.5 Prevalence

It is apparent that taurodontism shows varying prevalences in some populations, Studies on the prevalence of taurodontism have been carried out on a global scale, and range between 2 and 48%. These differences in prevalences may be attributed to the diversity in social structures and ethnic variations especially in growing populations. The diverse mixing of different nationalities in most countries highlights the importance of establishing the prevalence and implications of taurodontism. The literature provides variations in the prevalence of taurodontism between males and females; between maxillary and mandibular teeth; and between premolar and molar teeth. The highest prevalence was reported in China, Senegal and Turkey. This variability observed may be attributed to genetic and racial differences; sample selection, study methodology **(Shah *et al*., 2015; Benzahya.,2015).**

1.6 Clinical considerations

Taurodontism can complicate certain procedures for the dentist during extraction and endodontic, orthodontic and/or prosthetic treatment planning. Importance should be given to the value of diagnostic radiographs for early detection of taurodonts and rendering preventive care to such teeth. It is very

important for a dentist to be familiar with taurodontism not only with regards to clinical complications but also its management **(Dineshshankar *et al*., 2014; *Einy et al*., 2022; Mohan *et al*.,*2013)*.**

1.6.1 Endodontic considerations

The enlarged pulp chamber increases the chance of pulp exposure due to decay or during tooth preparation.

From an Endodontist's view, taurodontism presents a challenge during negotiation, instrumentation and obturation in root canal therapy. Because of the complexity of the root canal anatomy and proximity of buccal orifices, complete filling of the root canal system in taurodont teeth is challenging **(Sambandam and Ramesh, 2017; *Jadhav et al*., 2016; Majunatha and Kovvuru, 2010).**

High-quality diagnostic radiographs are very important during the endodontic treatment of such teeth *figure (1-9) (A)*. CBCT is a relatively new diagnostic imaging modality that has been used in endodontics for effective evaluation of root canal morphology. It has been important in locating and identifying root canals, mainly when anatomic variations and difficulties are found.

Endodontic access to the cavity was prepared on the occlusal surface. A huge pulp chamber was found, but the root furcation was difficult to identify. It was done with cutting concentrated more towards centre due to the large central orifice of pulp chamber. K-file was used to determine the working length *figure (1-9) (B)* **(Azzaldeen *et al*., 2017; Marques-da-Silva *et al*., 2010).**

The use of magnification with illumination using specialized equipment such as surgical loupes with LED lights, surgical operating microscopes and ultrasonic endodontic tips, greatly enhance the visualization of the pulpal floor by better visualization of the depths of the cavity, enabling easy identification of the root canal orifices **(Simsek *et al*., 2013; Unni and Kundabala, 2017).**

Chemo-mechanical preparation being voluminous nature of the pulp in taurodontic tooth, complete removal of the necrotic pulp should be confirmed. For this, 2.5% sodium hypochlorite has been suggested initially as an irrigant to dissolve pulp tissue completely. Moreover, as proper instrumentation of the irregular root canals cannot be performed, extra efforts should be made by irrigating the canals with 2.5% sodium hypochlorite in order to dissolve as much necrotic material as possible. Also, the addition of final ultrasonic irrigation may help complete pulp tissue removal **(Baranwal, 2016).**

Passive ultrasonic irrigation could be an important supplement for cleaning the root canal system, since, in comparison to traditional syringe irrigation, it can remove more organic tissue, planktonic bacteria, and dentin debris from the root canal. PUI is more efficient in cleaning canals than ultrasonic irrigation with simultaneous ultrasonic instrumentation. Ultrasonic files have been proved to be difficult in controlling the cutting of dentine during ultrasonic preparation, with the result that it is impossible to control the shape of the prepared root canal and apical perforations and irregular shapes were produced. Therefore, after shaping the root canal, cleaning can be completed with PUI or with a final flush of syringe irrigation. Well-shaped root canal provides better oscillation of the file and penetration of the irrigant into the apical part of the root canal system **(simsek *et al*., 2013).**

A modified filling technique has been proposed, which consists of combined lateral compaction in the apical region with vertical compaction of the elongated pulp chamber, using the system B device *figure (1-9) (D)* **(Mohan *et al*., 2013).**

In addition to the difficulty of the endodontic procedure, the possibility of taurodont teeth having an extraordinary root canal system which is challenging for endodontists **(Bharti *et al*., 2009).**

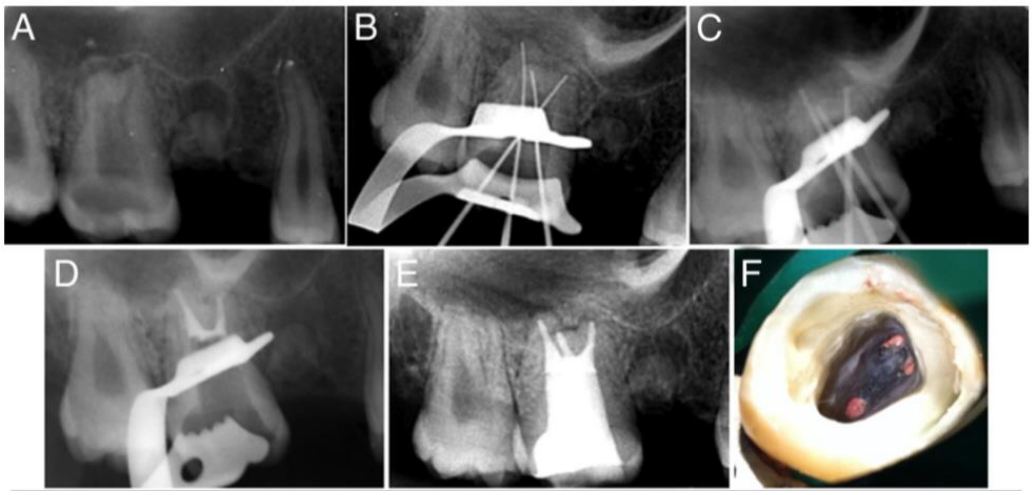

Fig (1-9): Root canal treatment of the rights maxillary second molar. **(A)** A preoperative radiograph, **(B)** Working length confirmation, **(C)** Master cone fit, **(D)** root canal filling using warm vertical compaction, **(E)** a postoperative radiograph after composite core buildup, **(F)** an occlusal view of the pulp chamber after root canal filling.

Finally, it should be noted that in cases of hypertaurodont (where the pulp chamber nearly reaches the apex and then breaks up into two or four channels) vital pulpotomy instead of routine pulpectomy may be considered as the treatment of choice **(Azzaldeen *et al*., 2016).**

1.6.2 Surgical construction

Extraction of taurodont tooth is usually complicated because of the shift in the furcation to apical third. It is reported that extraction of such teeth may not be a problem as large body with little surface area of a taurodont tooth is embedded in the alveolus, unless the roots are widely divergent. Few authors believe that hypertaurodonts may pose some problem during extraction because of apical shift of trifurcation or bifurcation due to difficulty in placement of forceps beaks. This problem can be overcome by proper use of surgical teeth elevators **(Thimmegowda *et al*., 2015).**

Extraction of teeth presenting taurodontism is usually complicated and could lead to a risk of mandibular fracture, especially in cases with tooth length extending to the basilar bone, Iatrogenic mandibular fracture associated with tooth removal can be the most serious complication and can occur immediately during the procedure or later in the first 4 weeks, being mostly associated with removal of third molars. Coronectomy is reported as a less traumatic treatment alternative, in which the tooth should be sectioned, removing only the crown and maintaining the roots and minimizing the extent of bone removal and the force caused by the instrumentation as shown in the *figure 1-10* **(Mendes *et al*., 2018).**

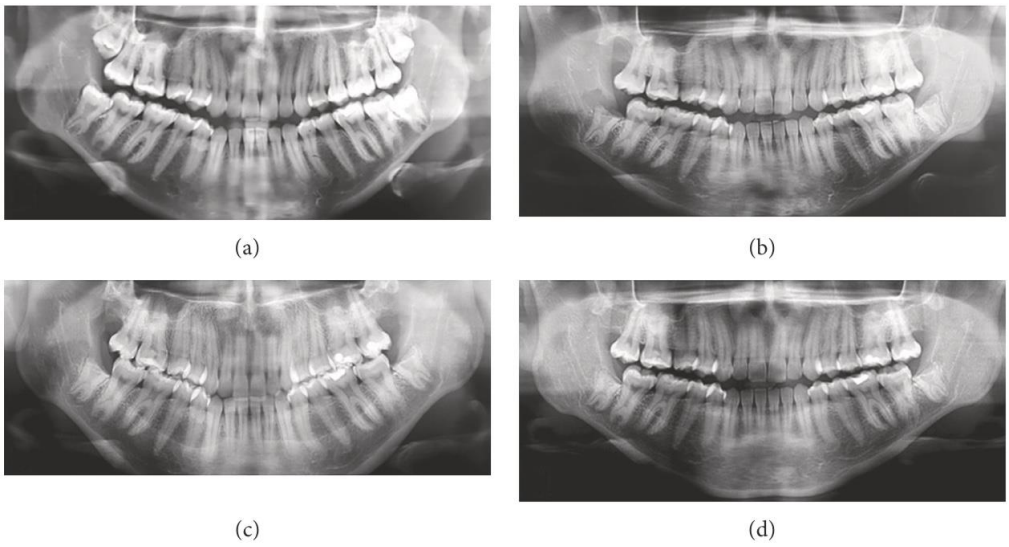

Fig (1-10): (a) Initial panoramic radiograph and **(b–d)** follow-up with 7 days, 6, and 12 months, respectively **(Mendes *et al*., 2018).**

1.6.3 Prosthetic consideration

Because less surface area of the tooth is embedded in the alveolus, a taurodont tooth may not have as much stability as a normal tooth (Cynodont) when used as an abutment for prosthetic purposes **(ML and Bhayya., 2018).**

1.6.4 Conservative consideration

In dentinal caries, during restoration cavity preparation in bull teeth, it needs a conservative cavity preparation such as minimal invasive procedures. The

restorative dentist was recommended to avoid post placement and use other techniques for tooth reconstruction. Preparing a compromised root in length and form for a post is definitely in question, but due to the improved abilities today to adhesively cement composite core materials to the dentinal walls, this post becomes redundant **(Einy *et al*., 2022; Thimmegowda *et al*., 2015; Nazari and MirMotalebi, 2006).**

The lack of a cervical constriction would deprive the tooth of the buttressing effect against excessive loading of the crown. Moreover, the remaining dentin thickness of these roots is less, leading to chances of root fracture, which is very high in such cases. Hence, it was decided to reinforce the root canal walls using a combination of glass ionomer restoration followed by light cured composite resin **(Thaha *et al*., 2015).**

1.6.5 Periodontal considerations

taurodont teeth may, in specific cases, provides the favourable prognosis. Where periodontal pocketing or gingival recession occurs, the chances of furcation involvement are very much less than those in normal teeth because taurodont teeth have to demonstrate significant periodontal destruction before furcation involvement occurs **(ML and Bhayya., 2018; Baranwal, 2016).**

1.6.6 Orthodontic consecration

The shorter and thinner roots of taurodont teeth are considerably more susceptible to resorption when orthodontic forces are applied for their movement. It is advised to avoid any orthodontic movement of tooth with taurodontism **(Datana *et al*., 2021; Yordanova *et al*., 2011).**

The anchorage value of the affected tooth is reduced, as there is reduction in the surface area of the root. The anchorage value of a taurodont molar tooth may be enhanced by adding more number of teeth in the anchored unit or with

indirect anchorage using orthodontic implants. Because of reduced root support, the use of headgear is contraindicated on taurodont molars.

Prolonged duration of orthodontic treatment may result in some undesirable effects; apical blunting or root resorption is one of the most commonly encountered problems with prolonged treatment **(Datana *et al*., 2021).**

The high incidence of taurodontism in hypodontic patients presents a clinical challenge for general dental practitioners and orthodonists alike. To successfully manage hypodontia the orthodontist should be able to identify taurodont teeth and correctly include them in the treatment plan.

The recommended approach in such cases is to limit the orthodontic teeth movement to only preparation procedures to facilitate any future prosthetic rehabilitation with fixed constructions. Or when the treatment plan involves closing of spaces using the available teeth, it is advisable that you should choose spontaneously closing gaps. This is possible with early extraction (8-9 years olds) of primary molar **(Yordanova *et al*., 2011).**

1.6.7 Pedodontic consideration

Daito's method was applied to the detailed classification of the *deciduous taurodont teeth* as shown in the *Figures (1-11) & (1-12)*. It is a useful method for evaluating deciduous molars because it can be used when the root is absorbed or when the root formation is incomplete **(Lim *et al*., 2020).**

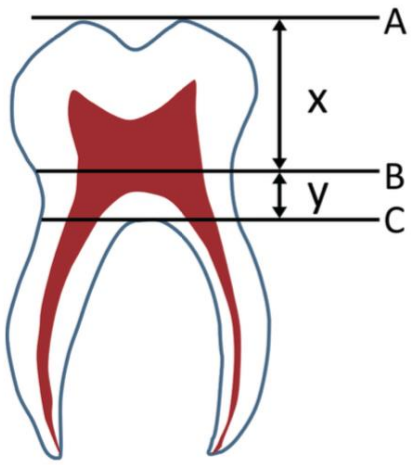

Fig (1-11): Detection of a taurodontism based on the criteria described by Daito. **(A):** The uppermost part of the crown, **(B):** the cementoenamel junction, **(C):** the furcation, x: the vertical distance between A and B, y: the vertical distance between B and C **(Lim *et al*., 2020).**

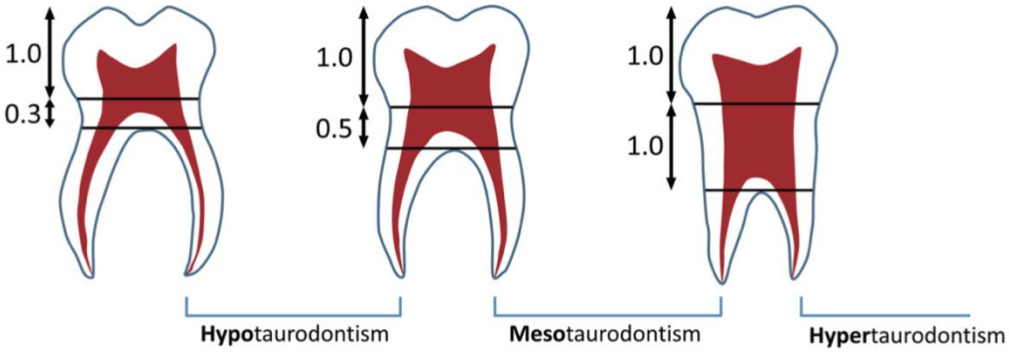

Fig (1-12): Classification of taurodontism deciduous teeth according to its severity by Daito's method **(Lim *et al*., 2020).**

Treatment for deciduous taurodont tooth which is grossly decayed tooth (loss of crown) with missing permanent successor, it has been recommended that post placement be avoided for tooth reconstruction, because of less surface area of the tooth is embedded in the alveolus. A taurodont tooth may not have as much stability as cynodont when used as an abutment for prosthetic purposes so extraction and followed by functional space maintainer should be the choice of treatment.

Placement of crown or space maintainer is difficult because of the anatomy and morphology of the crown and loss of cervical constriction at CEJ which extends to the bifurcation or trifurcation of root. Because of the anatomy and morphology of the crown in taurodont tooth, retention of the crown is difficult. So in such cases custom made crown may be advised. During placement of space maintainers in primary teeth, because of altered morphology of the tooth, preformed bands may not fit appropriately, hence custom made bands need to be used accordingly. **(Thimmegowda *et al*., 2015).**

For endodontic treatment, the access can easily be gained but locating orifices of canal is difficult. Increased hemorrhage observed during access preparation can be mistaken for perforation. However, since the roots are short and the pulpal floor is placed apically, it is important to be careful to avoid perforation **(simsek *et al*., 2013; Bafna *et al.*, 2013).**

Deciduous teeth anatomically have thinner dentin in comparison with permanent teeth. Therefore, for those teeth, we did not use ultrasonic irrigation but performed copious irrigation with 2.5% sodium hypochlorite instead. Full strength sodium hypochlorite (5.25%) was also avoided due to a potential allergic reaction to the chlorine component of sodium hypochlorite. Additionally, the whole procedure was performed under full isolation of a rubber dam to prevent any leakage **(Kamareh *et al*., 2019).**

Conventional obturating materials like Zinc oxide eugenol in bulk may take longer time to resorb which may delay the natural exfoliation of the tooth. In such cases combination of calcium hydroxide can act as a wonderful material due to its resorption rate. Endoflas as an obturating material can be used, which is a combination of zinc oxide eugenol, iodoform, calcium hydroxide and barium sulphate. This material has added advantage of faster rate of resorption due to presence of calcium hydroxide and iodoform.

Biomaterials such as mineral trioxide aggregate (MTA) and CEM showed favorable treatment outcomes for full pulpotomy of carious primary molars; CEM could be an effective and inexpensive pulp dressing biomaterial **(Kamareh *et al*., 2019; Hemalatha and Attavar, 2015).**

Due to the difficulty of root canal treatment with short roots, a pulpotomy may be considered as the first treatment option as the severity increases **(Lim *et al*., 2020).**

CHAPTER TWO

CONCLUSION

Conclusion

Taurodontism is one of the rare dental anomalies in modern man which needs special attention while performing any treatment. The thorough knowledge of etiology, anatomic and radiographic features, clinical considerations and its association with other syndromes of the dental rarity should be well-understood. Recognition of taurodontism in several separate genetic disorders have led to an increased awareness, necessitating cognizance of the possible existence of this characteristic when managing patients in the dental environment. It can be seen that taurodontism has until now received insufficient attention from clinicians.

REFERENCE

(A)

- Azzaldeen, A., Mai, A., Abu-Hussein, M., & Watted, N. (2017). Taurodontism an endodontic enigma: A case report. Indo Eur J Dent Ther Res, 6, 377-9.
- Azzaldeen, A., Mai, A., Nezar, W., & Muhamad, A. H. Taurodontism; Clinical Considerations.

(B)

- Bains, R., Jethwani, G. S., Loomba, K., Loomba, A., Dubey, O. P., & Bains, V. (2010). Taurodontism-Case report of a morpho-Anatomical variant. Endod Practice Today, 4, 301-8.
- Bafna, Y., Kambalimath, H. V., Khandelwal, V., & Nayak, P. (2013). Taurodontism in deciduous molars. Case Reports, 2013, bcr2013010079.
- Baranwal, A. K. (2016). Taurodontism: An anatomical challenge to clinical endodontics. Ann Prosthodont Restor Dent, 2(4), 105-9.
- Benzahya, M. (2015). Analysis of the occurrence of taurodontism in patients attending the Tygerberg Oral Health Centre.
- Bharti, R., Chandra, A., Tikku, A. P., & Wadhwani, K. K. (2009). "Taurodontism" an endodontic challenge: a case report. Journal of Oral Science, 51(3), 471-474.
- Bharath .KP, Priya, Poornima .P, Neena I.E. Non Syndromic Generalised Taurodontism in Primary and Permanent teeth -A Case Report. CODS J Dent 2015;7: 90-92.

(C)

- Chetty, M., Roomaney, I. A., & Beighton, P. (2021). Taurodontism in dental genetics. BDJ open, 7(1), 1-6.

(D)

- Datana, S., Agarwal, S. S., Bhandari, S. K., & Jain, D. (2021). Implication of taurodontism in orthodontic diagnosis and treatment planning: A review and case report. Journal of Dentistry Defence Section, 15(1), 43.
- Dineshshankar, J., Sivakumar, M., Balasubramanium, A. M., Kesavan, G., Karthikeyan, M., & Prasad, V. S. (2014). Taurodontism. Journal of pharmacy & bioallied sciences, 6(Suppl 1), S13–S15.

(E)

- Einy, S., Yitzhaki, I. H., Cohen, O., Smidt, A., & Zilberman, U. (2022). Taurodontism—Prevalence, Extent, and Clinical Challenge in Ashkelon, Israel—A Retrospective Study. Applied Sciences, 12(3), 1062.

(F)

- Fons Romero, J. M., Star, H., Lav, R., Watkins, S., Harrison, M., Hovorakova, M., ... & Tucker, A. S. (2017). The impact of the eda pathway on tooth root development. Journal of dental research, 96(11), 1290-1297.

(G)

- Ghabanchi, J., Haghnegahdar, A. A., Khodadazadeh, S. H., & Haghnegahdar, S. (2009). A radiographic and clinical survey of dental anomalies in patients referring to Shiraz dental school. Journal of Dentistry, 10(Supplement 2009), 26-31.
- Gomes, R. R., Habckost, C. D., Junqueira, L. G., Leite, A. F., Figueiredo, P. T., Paula, L. M., & Acevedo, A. C. (2012). Taurodontism in Brazilian patients with tooth agenesis and first and second-degree relatives: A case–control study. Archives of oral biology, 57(8), 1062-1069.

(H)

- HegDe, V., Anegundi, R. T., & Pravinchandra, K. R. (2013). Biometric analysis–A reliable indicator for diagnosing taurodontism using panoramic radiographs. Journal of Clinical and Diagnostic Research: JCDR, 7(8), 1779.
- Hemalatha, B., & Attavar, S. (2015). TAURODONTISM-A REVIEW.

(J)

- Jadhav, G., Lodaya, R., Chavan, A., & Salunkhe, N. Taurodontism in Pediatric Population: A.
- Jafarzadeh, H., Azarpazhooh, A., & Mayhall, J. T. (2008). Taurodontism: a review of the condition and endodontic treatment challenges. International endodontic journal, 41(5), 375-388.
- Jayashankara, C. M., Shivanna, A. K., Sridhara, K. S., & Kumar, P. S. (2013). Taurodontism: A dental rarity. Journal of oral and maxillofacial pathology: JOMFP, 17(3), 478.

(K)

- Kamareh, S., Kazem, M., Foroozandeh, M., & Gohari, A. (2019). Management of two taurodont primary molars with pulp involvement using calcium-enriched mixture cement pulpotomy in a patient with accompanied drug reaction with eosinophilia and systemic symptoms syndrome: a case report. Biomedical Research and Therapy, 6(5), 3184-3188.

(L)

- Lim, J. Y., Kim, I. H., & Song, J. S. (2020). Analysis of the Prevalence of Taurodont Deciduous Molars in Children. JOURNAL OF THE KOREAN ACADEMY OF PEDTATRIC DENTISTRY, 47(4), 438-445.

(M)

- Manjunatha, B. S., & Kovvuru, S. K. (2010). Taurodontism: A Review on its etiology, prevalence and clinical considerations.
- Marques-da-Silva, B., Baratto-Filho, F., Abuabara, A., Moura, P., Losso, E. M., & Moro, A. (2010). Multiple taurodontism: the challenge of endodontic treatment. Journal of oral science, 52(4), 653-658.
- Mendes, P. A., Neiva, I. M., Brasileiro, C. B., Souza, A. C. R. A., & Souza, L. N. (2018). Extending Coronectomy Indications to Third Molars with Taurodontism to Prevent Paresthesia and Mandible Fracture. Case Reports in Dentistry, 2018.
- ML, A. T., & Bhayya, H. (2018). Evaluation and comparision of various methods for assessing Multiple Taurodontism: A clinical study.
- Mohan, R. P. S., Verma, S., Agarwal, N., & Singh, U. (2013). Case Report: Taurodontism. BMJ Case Reports, 2013.
- Marques-da-Silva, B., Baratto-Filho, F., Abuabara, A., Moura, P., Losso, E. M., & Moro, A. (2010). Multiple taurodontism: the challenge of endodontic treatment. Journal of oral science, 52(4), 653-658.
- ISO 690

(N)

- NAZARI, S., & MirMotalebi, F. (2006). Endodontic treatment of a taurodontism tooth: Report of a case.

(O)

- Ono, W., Sakagami, N., Nishimori, S., Ono, N., & Kronenberg, H. M. (2016). Parathyroid hormone receptor signalling in osterix-expressing mesenchymal progenitors is essential for tooth root formation. Nature communications, 7(1), 1-16.

(S)

- Sambandam, T. V., & Ramesh, S. (2017). Taurodontism a challenge in endodontics: A case report. J. Adv. Pharm. Edu. Res, 7(3), 349-351.
- Shah, D., Garcha, V., Garde, J., & Ekhande, D. (2015). Prevalence of taurodontism among the patients visiting a dental teaching hospital in Pune, India: A retrospective orthopantomogram study. Journal of Indian Association of Public Health Dentistry, 13(1), 83.
- Simsek N, Keles A, Ocak MS. Endodontic treatment ofhypertaurodontism with multiple bilateral taurodontism. JConserv Dent 2013;16(5):477-479.
- Sivapathasundharam, B. (2020). Shafer's Textbook of Oral Pathology-E Book. Elsevier Health Sciences.

(T)

- Thaha KA, Sakkir N, Nair MG, Ajaz A,Parackal LI. Endodontic Management of a TaurodonticMandibular Second Molar. Cons Dent Endod J 2016;1(1):14-1
- Thimmegowda, U., Arali, V., Nagarathna, C., & Basavarajendrappa, R. C. (2015). Non Syndromic Form of Bilateral Bimaxillary Bull Teeth-A Case Report with Challenges in Pediatric Dentistry. OHDM, 14, 405-8.
- Tokavanich, N., Wein, M., English, J. D., Ono, N., & Ono, W. The role of Wnt signaling in postnatal tooth root development. Frontiers in Dental Medicine, 79.

(U)

- Unni, P. V., & Kundabala, M. (2017). Endodontic Therapy of Maxillary Third Molar with Supernumerary Root with Four Root Canals-A Rare Case. Biomed J Sci& Tech Res, 1(4).

(Y)

- Yordanova, M., Yordanova, S., & Tomov, G. (2011). Orthodontic problems in patients with hypodontia and taurodontism of permanent molars. J IMAB, 17, 109-13.