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Taurodotism: Etiology, Classification And Clinical Significance

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Abstract
Anatomical and morphological variations in teeth are important to be diagnosed and thus taken care of during treatment. Taurodontism is a developmental disturbance of a tooth that lacks constriction at the level of the cementoenamel junction (CEJ). Taurodontism, although not common, is an important occurrence that may influence dental management of patients. So this review outlines the classification, diagnosis and clinical importance of such uncommon taurodont teeth.

Key Words
taurodontism; anatomical variations; clinical significance

Introduction

Human dentition presents a variety of anatomical and morphological variations. The anatomy of the root canal system dictates the conditions under which root canal therapy is carried out and can directly affect its prognosis[1]. One of the most important abnormalities in tooth morphology is **taurodontism**. This abnormality is a developmental disturbance of a tooth that lacks constriction at the level of the cementoenamel junction (CEJ) and is characterized by vertically elongated pulp chambers, apical displacement of the pulpal floor, and bifurcation or trifurcation of the roots[2] **(Fig 1)**. Taurodontism, although not common, is an important occurrence that may influence dental management of patients.

External morphology was first used to describe those teeth that had apically displaced furcation areas. It was first described by Gorjanovic´-Kramberger K.[3]; although the earliest example of taurodontism is that of the Krapina Neanderthal race, 70,000 years old anthropological specimen[4]. However, the term taurodontism was first introduced by Sir Arthur Keith[5] to describe molar teeth resembling those of ungulates, particularly bulls. So, the term taurodontism comes from the Latin term 'tauros', which means 'bull' and the Greek term 'odus', which means 'tooth' or 'bull tooth'[5].

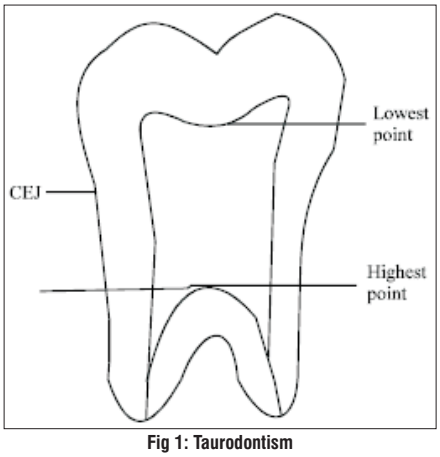

Fig 1: Taurodontism

Incidence

Witkop CJ[6] suggested that taurodontism was found more often in people in which teeth were used as tools, as more advantageous than cynodontism in people with heavy masticatory habits. It has also been seen in Eskimos, Europeans, African Americans, and in white Americans[7]. However, Sciulli PW[8] found no evidence of taurodontism in prehistoric American Indians, people who must have also used their teeth extensively.

Pindborg JJ[9] stated that the prevalence of taurodontism in modern man is less than 0.1%. However, Blumberg JE et al.[10] found it in about 2.5% of cases. Keene HJ[11] reported hypo taurodontism in 2.8% of cases and mesotaurodontism in 0.4% cases. Further, Shifman A and Chanannel I[12] showed hypo taurodontism in 5.2% of cases, mesiotaurodontism in 1.0% and hyper taurodontism in 0.7%. So, they suggested that taurodontism is not rare in modern man as previously thought, infact hypotaurodontism is just variation of normal, but hypertaurodontism is yet a rare entity.

The teeth involved are mostly molars-sometimes only a single tooth and other times several molars in the same quadrant. Sert S. and Bayrili G.[13] reported a patient that had six taurodont molar teeth, 4 maxillary and two mandibular molars. Similarly, Shifman A and Buchner A[14] reported that in one case, eight teeth were taurodonts. The mandibular second molar is the most prone, being involved in two third of all the cases found [12, 14]. It is reported that the degree of taurodontism increases from the first to the third molar 2,[15]. Also, reported that taurodontism is occasionally observed in mandibular and maxillary premolars, and even

mandibular canines and incisors[15,16].
Taurodontism may affect the deciduous or permanent dentition[2,17,18,19]. The condition may be unilateral or bilateral and in any combination of teeth or quadrants[20]. Shifman A and Buchner A[14] also reported that the majority of the affected teeth occurred singly. However, Laatikainen T and Ranta R[21] found that taurodontism was symmetrical in 91% of the affected molar pairs.
The gender distribution of the patients with taurodontism showed no statistically significant difference[21] except for a higher prevalence amongst females in a Chinese population[17].

Etiology

The etiology of taurodontism is unclear. It is thought to be caused by the failure of Hertwig's epithelial sheath diaphragm to invaginate at the proper horizontal level, resulting in a tooth with short roots, elongated body, an enlarged pulp, and normal dentin[22]. Interference in the epitheliomesenchymatose induction has also been proposed as a possible aetiology[23].
Previously, taurodontism was related to various syndromes such as Down's and Klinefelter's[24]. So suggested that taurodontism may be genetically transmitted[25, 26]. Varrela J and Alvesalo L[27] supported the concept that the prevalence of taurodontism increases as the number of X chromosomes increases and also indicate that expression of the trait and the number of X chromosomes may be positively correlated. They have further suggested that the X chromosome gene(s) influencing development of enamel may also be involved in the development of taurodontism.
Except genetic transmission, other external factors can also damage developing dental structures in children and adolescents as infection (osteomyelitis)[28], disrupted developmental homeostasis[29], high-dose chemotherapy[30], and a history of bone marrow transplantation[31].
But now a days, taurodontism especially hypotaurodontism is considered as an anatomic variance that could occur in a normal population[12].

Classification

The common problem that arises in taurodontism is that there are differences of opinion regarding how much displacement and how much morphologic change constitutes taurodontism. Another problem complicating accurate assessment of the incidence of taurodontism is the inclusion of premolars or anteriors by many investigators[32,23], whereas others have questioned this inclusion[33].
Shaw JCM gave first classification ever done for taurodonts in the year 1928, according to its severity[34]: normal tooth- cynodont; least pronounced- hypotaurodontism: moderate enlargement of the pulp chamber at the expense of the roots; moderate - mesotaurodontism: pulp is quite large and the roots short but still separate; and most severe- hypertaurodontism: prismatic or cylindrical forms where the pulp chamber nearly reaches the apex and then breaks up **(Fig 2)**. This classification is usually preferred but it is not an objective analysis.
Keene HJ[11] in 1966 gave the taurodont index in order to classify the degree of taurodontism as ratio of height of pulp chamber to the length of the longest root.

$$\text{Taurodont Index} = \frac{\text{height of pulp chamber}}{\text{length of the longest root}}$$

According to this index, value of
0 - 24% is cynodont,
25- 49.9% is hypotaurodont,
50- 74.9% is mesotaurodont
and 75- 100% is hypertaurodont.

The major drawback of this index is that it makes use of landmarks in biological structure which are liable to change with time due to formation of reparative dentin.
Another method was discussed by Blumberg et al.[10] in 1971. Though his landmarks were relatively stable, but the formula was quite cumbersome for regular clinical use.
So, Feichtinger C & Rossiwall B.[34] further on the basis of the work of earlier authors, gave an easier method and stated that if the distance from the furcation of the roots to the cementoenamel junction was greater than the occlusal cervical distance, taurodontism is present.
Further, Shifman A and Chanannel I[12] in

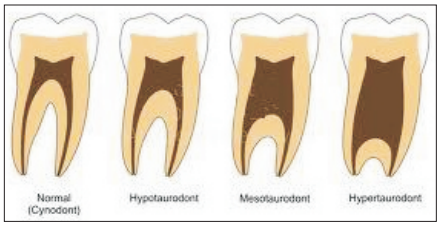

Fig 2: Classification Of Taurodontism

1978 also included an index to calculate the degree of taurodontism as shown radiographically. It was based on the relative amount of apical displacement of the pulp chamber floor. As per their index, taurodontism is present if the distance from the lowest point at the occlusal end of the pulp chamber (A) to the highest point at the apical end of the chamber (B) divided by the distance (b) from A to the apex is 0.2 or greater; and if the distance from the highest point at the apical end of the chamber to the cementoenamel junction (CEJ) is greater than 2.5 mm.

Degree of taurodontism was determined to be: hypotaurodontism if TI is 20-30%, mesotaurodontism if TI is 30-40% and hyper taurodontism if TI equals 40-75%[12].
This index has overcome many disadvantages of previous methods, however in few cases this formula fails, as in teeth that subjectively appeared to be taurodonts but did not meet the above criteria[33] due to strange pulp configuration.
In addition to all these methods, Tulensalo T. et al.[36] examined a simple method of assessing taurodontism using orthopantomograms (OPG) by measuring the distance between the baseline (connecting the mesial and distal points of the CEJ) and the highest point of the floor of the pulp chamber. They concluded that this technique is reliable in epidemiologic investigations for assessing taurodontism in a developing dentition.

Clinical and radiographic features

A taurodontic tooth has certain anatomic

$$\text{Taurodontism index} = \frac{\text{Distance From The Lowest Point At The Occlusal End Of The Pulp Chamber To The Highest Point At The Apical End Of The Chamber}}{\text{Distance From The Lowest Point At The Occlusal End Of The Pulp Chamber To The Apex}} \times 100$$

characteristics. First, the cervical constriction is less marked than the normal tooth form. Further, the tooth must have an apically displaced furcation and short roots. However, clinically the taurodont appears as a normal tooth because body and roots of a taurodont lie below the alveolar margin.

Radiographically, involved teeth are frequently found to be rectangular in overall shape rather than tapering toward the roots. The pulp chamber is extremely large with a much greater apico-occlusal height than normal. In addition, the pulp lacks the usual constriction at the cervical region of the teeth and the roots are exceedingly short. The bifurcation or trifurcation may be only a few millimeter above the apices of the roots.

Diagnosis

The above described external features have been primarily used for the diagnosis of taurodontism. However, it should be noted that gross external characteristics are not sufficient to generate diagnosis[15]. Further, clinical crowns of these teeth have near to normal characteristics; therefore, taurodontism may be diagnosed only radiologically either from IOPA or OPG.

Syndromes

Taurodontism appears mostly as an isolated anomaly; but it has also been associated with several syndromes like Down syndrome, Klinefelter's syndrome, trichodento-osseous syndrome, and others[37-42]. 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.. So, dentist being familiar with taurodontism may disclose systemic problems that would otherwise remain undetected[6]. Several patients with taurodontism associated with some other recognizable dental anomaly are seen. In these cases, there is no reason to suspect that taurodontism and the other anomaly were linked.

Clinical significance

The presentation of taurodont forms complicates nonsurgical, endodontic procedures because of the impact of the morphology on location of orifices and instrumentation and obturation[43]. Although there is a characteristic radiographic picture, the pretreatment films provide little information about the root canal system[23]. Finally, the results of pulp testing contribute little information about the effect of a large pulp chamber on tooth sensitivity[43].

There are different views regarding access cavity design and preparation: Shifman A & Buchner A[14] argued that access to the root canal orifices can easily obtained as the floor of the pulp chamber cannot affected by the formation of reactionary dentine as in normal teeth. In contrast, Durr et al.[44] suggested that morphology could hamper the location of the orifices, thus creating difficulty in instrumentation and filling. It also shows wide variation in the size and shape of the pulp chamber, varying degrees of obliteration and canal configuration, apically positioned canal orifices, and the potential for additional root canal systems.

A complicated root canal treatment has been reported for a mandibular taurodont tooth with five canals, only three of which could be instrumented to the apex[45]. Therefore, careful exploration of the grooves between all orifices is recommended to reveal additional orifices and canals. Further use of magnification[43] is helpful in easy location of the canal orifices.

Because the pulp of a taurodont is usually voluminous, in order to ensure complete removal of the necrotic pulp, 2.5% sodium hypochlorite has been suggested initially as an irrigant to digest pulp tissue[46]. Moreover, as adequate instrumentation of the irregular root canal system cannot be anticipated[47], suggested that additional efforts should be made by irrigating the canals with 2.5% sodium hypochlorite in order to dissolve as much necrotic material as possible. Application of final ultrasonic irrigation may ensure that no pulp tissue remains[46].

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[2,14].

Because of the complexity of the root canal anatomy and the proximity of the buccal orifices, complete filling of the root canal system in taurodontism is challenging. 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 (EIE / Analytic Technology, San Diego, CA, USA)[43].

About the surgical part, extraction of a taurodont tooth is usually complicated because of a dilated apical third[24]. In contrast, it has also been hypothesized that because of its large body, little surface area of a taurodont tooth is embedded in the alveolus. This feature would make extraction less dif?cult[44].

For the prosthetic treatment of a taurodont tooth, it has been recommended that post-placement be avoided for tooth reconstruction[43]. Further as less surface area of the tooth is embedded in the alveolus, a taurodont tooth may not have as much stability as a cynodont when used as an abutment for either prosthetic or orthodontic purposes[44].

From a periodontal standpoint, taurodont teeth may, in specific cases, offer favorable prognosis. Where periodontal pocketing or gingival recession occurs, the chances of furcation involvement are considerably less than those in normal teeth because taurodont teeth have to demonstrate significant periodontal destruction before furcation involvement occurs[2,14].

Conclusion

It can be seen that taurodontism has received insufficient attention from clinicians. Special attention is required to indentify the anomaly. In performing root canal treatment on these teeth, one should appreciate the complexity of the root canal system. Careful exploration of the grooves between all orifices, particularly with magnification; ultrasonic irrigation; and a modified filling technique are recommended. Care should also be exercised during extractions and post endodontic rehabilitation. Finally although taurodontism is a dental rarity, this unusual radicular form should be considered during planning the treatment.

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