Taurodontism: from Neanderthals till modern human population

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Abstract

Introduction. Taurodontism is an aberration of teeth that lacks the constriction at the level of the CEJ and characterized by elongated pulp chambers and apical displacement of bifurcation or trifurcation of the roots, giving it a rectangular shape. Aim. To summarize the available literature on taurodontism phenomenon in the contexts of paleodontology, evolutionary biology and clinic. Materials and methods. In order to clarify the prevalence of taurodontism in modern dentitions and the critical need for its true diagnosis and management, this review addresses the aetiology, clinical and radiographic features of taurodontism, its association with various syndromes and anomalies, as well as important considerations in various areas of expertise dental treatments of such teeth. Results. Although permanent molar teeth are most commonly affected, this aberation can also be seen in both the permanent and deciduous dentition, unilaterally or bilaterally, and in any combination of teeth or quadrants. Whilst it appears most frequently as an isolated anomaly, its association with several syndromes and abnormalities has also been reported. Discussion. It is apparent that taurodont teeth are presumed characteristic of neanderthal man and are still present as a morphological entity in modern man. The occurrences seem to have a biased racial expression in different populations. It can be seen that taurodontism has until now received insufficient attention from clinicians. No long-term follow-up studies have been published regarding treatment of taurodont teeth. Despite the clinical challenges, taurodontism has received little attention from clinicians.

Keywords: taurodontism; dental anomalies; clinical considerations

Introduction

Dental morphological traits are of particular importance in the study of phylogenetic relationships and population affinities. 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.
The term taurodontism comes from the Latin term tauros, which means “bull” and the Greek term odus, which means “tooth” or “bull tooth”. It was first described by Gorjanovic´-Kramberger, (1); however, the term taurodontism was first introduced by Sir Arthur Keith (1913) to describe molar teeth resembling those of ungulates, particularly bulls. The interest in these forms of molars first arose following the discovery of fossil remains of the Neanderthal race at Krapina in Croatia in 1899 (1). Taurodontism is prominent amongst the Krapina Neanderthal specimens and the earliest example of taurodontism is that of a Krapina 70.000 year old anthropological specimen (1). Sir Arthur Keith suggested that taurodontism is a distinctive characteristic of the Neanderthals. Later excavations at the Pontnewydd Cave in Denbighshire (Figure 1), “Bau de l’Aubésier”, France (Figure 2) and Lakonis, Greece (Figure 3) yielded a series of isolated human teeth with taurodontism. The “Aubesier 10” maxillary molar consists of a slightly worn right M1 or M2 with minimal marginal postmortem erosion. Its buccolingual crown diameter of 12.0 mm is similar to those of late Middle Pleistocene. It is notable for its pronounced taurodontism (Figure 2), in which the clefts between the roots are 72.7%, 75.3% and 79.2% of the maximum height of the root.
Arthur Keith 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) and could not have been evolved from such taurodont teeth. The controversy engendered by this hypothesis over the years has been vigorous. Because of the prevalence of taurodontism in modern dentitions and the critical need for its true diagnosis and management, this review addresses the aetiology, anatomic and radiographic features of taurodontism, its association with various syndromes and anomalies, as well as important clinical considerations in the dental treatment of such teeth.

Figure1. Maxillary molar excavated from Pontnewydd Cave in Denbighshire (photography and X-ray image), showing taurodontism characteristic of early Neanderthal (source: http://palaeo.gly.bris.ac.uk/Fossilsites/page48.html)

Figure 2. Middle Pleistocene human dental remains from the Bau de l'Aubesier, France, represents maxillary molar with pronounced taurodontism (Courtesy of S. Lebel and E. Trinkaus)

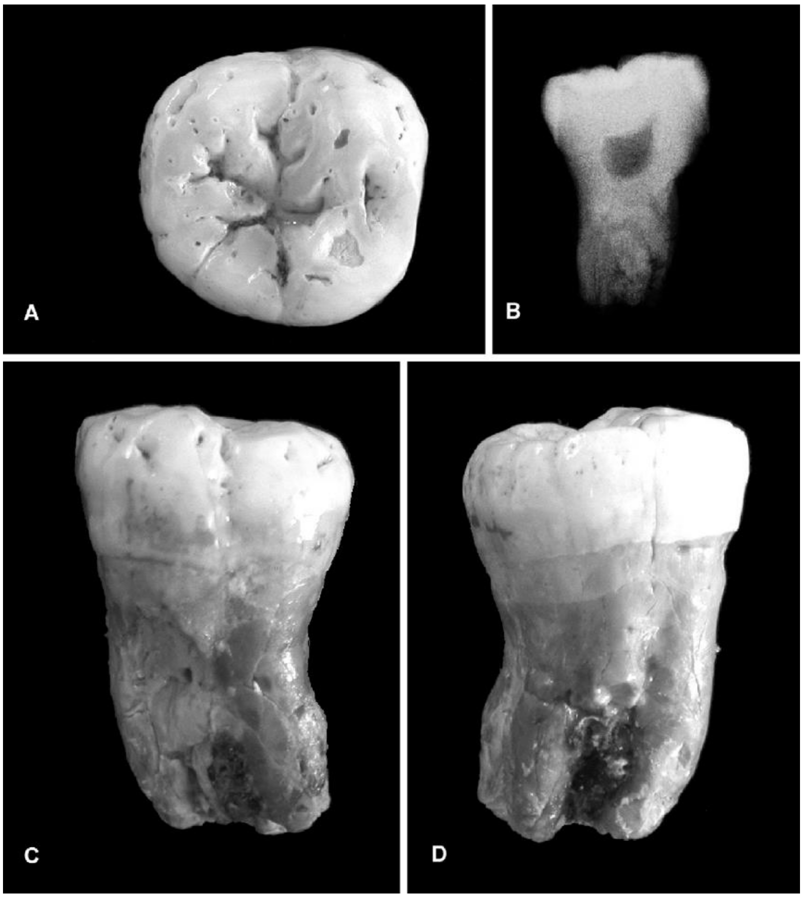

Figure 3. A Neanderthal left M 3 found in LKH 1, . (A), occlusal view; (B) radiograph of lateral view; (C) buccal view; (D) lingual view (Harvati K, Panagopoulou E, Karkanas P. First Neanderthal remains from Greece: the evidence from Lakonis. J Hum Evol. 2003 Dec;45(6):465-73.)

Prevalence

Review of the literature reveals a wide discrepancy in the prevalence of taurodontism in different populations (3-8). Its prevalence has been reported to range between 5.67% and 60% of subjects (3-8). The prevalence of taurodontism in children was found in 0.3% (6). A study on a group of Jordanian dental patients has shown an overall prevalence of 8% for individuals (4). Shifman and Channanel (3) found a prevalence of 5.6% in Israeli dental patients, compared with 46.4% in young adult Chinese (7). These variations in prevalence between different populations may be due to ethnic variations, but may also be influenced by differences in criteria used for interpretation of taurodontism and also the specific teeth examined (8). Some studies (9) have included premolars, while others (6-8) believe that premolar teeth may not be affected by taurodontism.

Etiology

Taurodontism is caused by the failure of Hertwig’s epithelial root sheath diaphragm to invaginate at the proper horizontal level (10). Interference in the epitheliomesenchymatose induction has also been proposed as a possible aetiology (9). Some reports suggest that taurodontism may be genetically transmitted (11-20), and could be associated with an increased number of X chromosomes. However, other researchers have found no simple genetic association but have noticed a trend for X chromosomal aneuploidy amongst patients with more severe forms of the trait (12). These chromosomal abnormalities may disrupt the development of the tooth's form; however, a specific genetic abnormality cannot be ascribed to taurodontism (12) biometrically studied the trait, ascribed taurodontism to a polygenic system, and described the anomaly as a continuous trait without discrete modes of expression. It is also proposed that taurodontism is a genetically determined trait and more advantageous than cynodontism in people with heavy masticatory habits, in populations in which teeth were used as tools (12). Despite this theory, no evidence of taurodontism has been found in prehistoric.

Classification

In 1928 Shaw (8) classified this condition as hypotaurodontism, mesotaurodontism and hypertaurodontism based on the relative displacement of the floor of the pulp chamber (Figure 4). This subjective, arbitrary classification led normal teeth to be misdiagnosed as taurodontism. In 1977, Feichfnger and Rossiwall (20) stated 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. Though there are many classification systems to determine the severity of taurodontism, Shifman and Chanannel (3) in 1978 proposed a new classification and is the widely used system till now.

Diagnosis

The 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. In many cases, precise biometric methods are essential in diagnosis of taurodontism (3). Tulensalo et al. (21) examined a simple method of assessing taurodontism using orthopantomograms 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 (Figure 5). They concluded that this technique is reliable in epidemiologic investigations for assessing taurodontism in a developing dentition.

In taurodontism, the pulp chamber is extremely large and elongated with much greater apicoocclusal height than normal (21) and, thus, extends apically below the CEJ (10). The CEJ constriction is less marked than that of the normal tooth, giving the taurodont a rectangular shape. Also, the furcation is displaced apically, resulting in shorter roots whilst enlarging the body of the tooth (9, 10, 22).

Clinical and radiographic characteristics

Clinically, a taurodont appears as a normal tooth. In fact, because the body and roots of a taurodont tooth lie below the alveolar margin, its distinguishing features cannot be recognized clinically (10). Therefore, the diagnosis of taurodontism is usually a subjective determination made from diagnostic radiographs (22). The radiographic features of taurodont tooth are: extension of the rectangular pulp chamber into the elongated body of the tooth, shortened roots and root canals, location of furcation (near the root apices), despite a normal crown size (10). It should be noted that taurodontism may be masked by wear-induced secondary dentine deposition so caution should be employed in interpreting an expression of taurodontism in heavily worn molars.

Conditions associated with taurodontism

Taurodontism appears most frequently as an isolated anomaly. However, its association with several syndromes and abnormalities has also been reported (12,15-20). Many of these disorders have oral manifestations, which can be detected on dental radiographs such alterations in the morphology or chemical composition of the teeth; thus, dentists may be the first to detect them (12). Taurodontism has been found to occur in patients with several medical conditions and syndromes. This may be related to its genetic aetiology. A close association of taurodontism and X-chromosomal aneuploid states has been demonstrated. Klinefelter syndrome (also known as 47, XXY or XXY syndrome) is a genetic disorder affecting about 1.2 in 1000 males (15, 20) and is characterised by tall stature, hypogonadism, androgen deficiency and female traits such as wide hips and sparse facial hair. The syndrome is caused by a non-dysjunction of the X-chromosome during parental gametogenesis prior to fertilisation of an egg by sperm. Although taurodontism is not pathognomonic for Klinefelters syndrome it is one of the anomalies frequently associated with it. A number of other conditions that have been associated with taurodontism include: Cleft lip and palate, Orofaciodigital syndrome, Tricho-dento-osseous syndrome, Down's syndrome, Ectodermal dysplasia, Hypo- and Oligodontia (8,15-20,25,26).

Treatment considerations

Endodontic treatment: Localisation and instrumentation of the root canals may be more difficult due to the apically positioned pulp chambers (23, 24, 27). The number of roots and root canals may be variable depending on whether the tooth is hypotaurodont, mesotaurodont or hypertaurodont (23, 27). Bifurcation or trifurcation of roots may challenge the endodontist with pronounced curves of the root canal that make canal preparation very difficult. A modified obturation technique has been proposed as a result of the complexity of the inner root canal and the proximity of buccal orifices (23, 27). In addition, there may also be an increased proportion of pulp stones (26.7%) in taurodont molars (27). The use of magnification has been advocated in several case studies in order to overcome the difficulties posed by the altered morphology.

Dental extractions: These may be more complicated in taurodontism as the tooth furcation is located more apically. In addition the root apices may be shorter and thinner and therefore more liable to fracture during extraction. Extraction of taurodont molars may also pose a challenge to the clinician. Firm control of the tooth may be compromised due to the dilated apical third, and conventional molar extraction forceps designed to engage the furcation of the tooth may not be as effective in taurodont teeth due to the more apical position of the furcation. In addition, the conventional rotational force usually applied during an extraction is contraindicated (22, 26).

Root resorption: The shorter thinner roots in taurodontism may be subject to external root resorption during fixed appliance orthodontic treatment. Fixed appliance orthodontic treatment may cause external root resorption in taurodont molars (22). This resorption pattern is an inevitable consequence of orthodontic tooth movement and is as yet a poorly understood condition (13, 25). It is thought to be related to the inflammatory response produced at a cellular level when an orthodontic force is applied to a tooth and tooth movement initiated. Both external and internal root resorption may be affected by multiple factors such as the age of the patient, medical history, previous trauma, tooth impaction and the morphology of the apical third of the root. A careful risk-analysis must be carried out prior to commencing orthodontic treatment. This should form the basis of a discussion for informed consent to be obtained at the start of the treatment.

Orthodontic anchorage: This is likely to be reduced by the shorter roots (13). The altered morphology of taurodont molar teeth also has an effect on the total root surface area. This may in turn affect the anchorage value of a taurodont molar during orthodontic treatment. This is another consideration that needs to be borne in mind at the treatment planning stage (13, 25). The use of head gear to reinforce anchorage of taurodont upper molars is contraindicated (13) because of the increased risk of root resorption.

Restorative management: Post endodontic restorative management of such teeth is affected by the presence of a large pulp cavity located in a more apical position (26). Restoration of a taurodont molar maybe more difficult following endodontic therapy. This is because the crown of the tooth would have been more extensively compromised to gain access to the pulp chamber that is situated more apically. Consequently in order to support a full coverage crown for example, the coronal structure has to be extensively restored (26).

Conclusion

From this review, it is apparent that taurodont teeth are presumed characteristic of neanderthal man and are still present as a morphological entity in modern man. The occurrences, however, seem to have a biased racial expression in different populations. These variations in prevalence between different populations may be due to ethnic variations, but may also be influenced by differences in criteria used for interpretation of taurodontism and also the specific teeth examined. This review attempts to address the etiology, radiographic features and clinical considerations in the treatment of such teeth. It can be seen that taurodontism has until now received insufficient attention from clinicians. No long-term follow-up studies have been published regarding treatment of taurodont teeth.

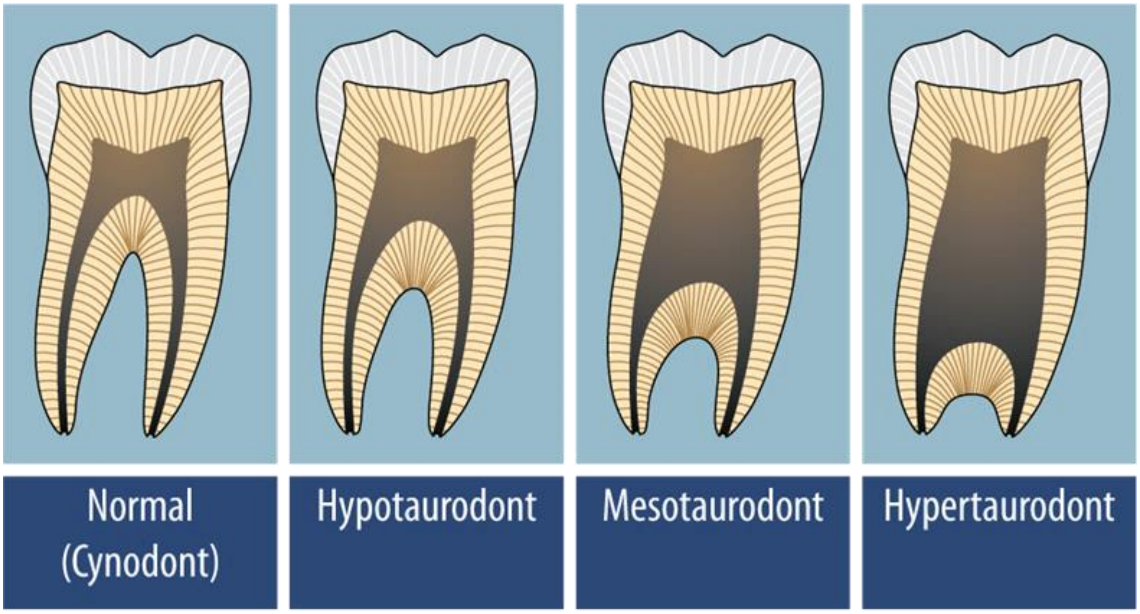

Figure 4. Subclasses of taurodontism according Shaw (1928). External morphological criteria (based on the relative amount of apical displacement of the pulp chamber floor). (Pictures by Georgi Tomov).

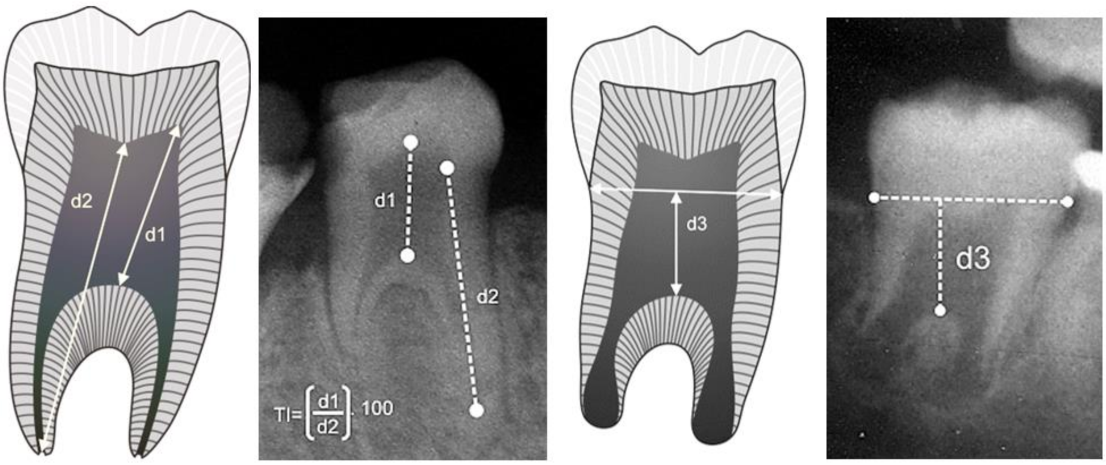

Figure 5. Taurodontic index in permanent dentition and in permanent teeth with incomplete root development. Taurodontic index of Shifman and Chanannel TI=d1/d2.100> 20 or taurodontic index of Tulensalo et al. d3>3.5mm are used to diagnose taurodontism. (Courtesy of Dr. Georgi Tomov).

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