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The Prevalence of Taurodontism in Permanent First and Second Molars among the Bangladeshi Population and its Significance in Genetics, Forensic Odontology, and Endodontics

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Abstract

Background: Taurodontism is a dental anomaly in which the pulp chamber is enlarged and the root canals are greatly shortened, usually in molar teeth. It is important in genetics, forensic odontology, and endodontics, as the condition alters the root morphology and creates complications in treatment. This study aimed to assess the prevalence of taurodontism within the permanent first and second molars of the Bangladeshi population, thereby understanding its significance in genetics, forensics, and endodontics.

Methods: A total of 2,700 participants aged 18–65 were examined at the Department of Conservative Dentistry and Endodontics, Sapporo Dental College and Hospital, Dhaka, Bangladesh. Radiographic analysis was conducted to identify taurodontism in permanent first and second molars, and data were collected on participants' family history, sex, and age. Cases were evaluated for root morphology complexity and treatment challenges. Self-reported family history was recorded to assess potential genetic trends.

Results: The study found a taurodontism prevalence of 8.7% among 2700 Bangladeshi participants, with 4.7% in permanent first molars and 4.0% in permanent second molars. Endodontic challenges were noted in 40.2% of cases due to complex root morphology. Participants with a positive family history of dental anomalies showed a 14.9% prevalence, highlighting potential genetic associations. Taurodontism's unique features also demonstrated forensic value in personal identification.

Conclusion: Taurodontism has significant implications for genetic inheritance, endodontic treatment, and forensic identification. The study's findings underscore taurodontism's clinical relevance, highlighting the need for increased awareness among dental practitioners for accurate diagnosis and treatment planning.

Keywords: Dental anomaly, Taurodontism, Molars, Genetics, Forensic odontology, Endodontics.

Introduction

Taurodontism is a dental anomaly characterized by an enlarged pulp chamber and shortened roots, primarily affecting the molars [1]. This condition arises due to the failure of the epithelial diaphragm to invaginate at the proper level during root formation, resulting in elongated pulp spaces and diminished root structure [2]. Taurodontism first described by Sir Arthur

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Keith in 1913 derives from the Latin terms "tauro" (meaning "bull") and "dont" (meaning "tooth") as the affected tooth resembles the molars seen in some ungulates like bovines [3]. The condition can vary in its expression, typically classified into mild, moderate, or severe forms based on the level of pulpal expansion [4].

Although taurodontism is relatively rare, its presence carries clinical and diagnostic significance, especially in endodontics, forensic odontology, and genetic studies [5]. Endodontically taurodontism presents unique challenges due to the enlarged pulp chambers and atypical root morphology which complicates standard root canal treatment procedures [6]. Root canals in taurodont teeth are often more challenging to locate and navigate due to their unusual shape leading to increased risks in treatment [7]. From an endodontic perspective, awareness of taurodontism can aid dental professionals in better managing these cases improving procedural outcomes, and reducing potential complications [8]. Beyond endodontics, taurodontism holds forensic value as its distinct morphology provides identifiable features that may assist in human identification processes [9]. Dental records particularly radiographic images displaying taurodontism can be critical in forensic investigations when typical identification methods are challenging [10]. Therefore, a deeper understanding of taurodontism's prevalence in specific populations can enhance forensic records and improve identification accuracy [11].

Genetically, taurodontism is notable for its potential association with various syndromic conditions, such as Klinefelter syndrome, Down syndrome, and Tricho-Dento-Osseous syndrome, where taurodont molars are observed more frequently than in the general population [12]. These genetic associations make taurodontism a feature of interest in studies exploring dental anomalies in hereditary conditions [13]. It is thought that specific genetic mutations may influence molar development, contributing to taurodontism [14]. Investigating the prevalence of taurodontism can, therefore, provide insights into the broader genetic and developmental mechanisms impacting craniofacial morphology [15]. Studying taurodontism in a population-based context may also reveal patterns that could be relevant to understanding localized genetic markers, particularly in homogenous populations such as the Bangladeshi population, where genetic diversity may yield specific trends in dental anomalies [16].

The present study will investigate the prevalence of taurodontism in Bangladeshi adults visiting the Department of Conservative Dentistry and Endodontics at Sapporo Dental College and Hospital, Dhaka. So far no study regarding taurodontism in Bangladesh has evaluated its significance in genetics, forensic odontology, and endodontics. Therefore, the present study will fill the lacuna with distribution according to molar type, demographic characteristics, endodontic complexities, genetic tendency, and forensic importance of taurodontism. The results will add to the awareness among dental practitioners and researchers for better diagnosis and treatment planning in the Bangladeshi population.

Methodology and Materials

This study was conducted following the Declaration of Helsinki (1975), as revised in 2013. Ethical approval was obtained from the Ethical Review Committee of Sapporo Dental College & Hospital (Approval No. 2022/03; Approval Date: June 4, 2022), and informed consent was obtained from all participants before data collection. This descriptive cross-sectional study was conducted within the Department of Conservative Dentistry and Endodontics, Sapporo Dental College and Hospital, Dhaka, from July 2022 to June 2024. A total of 2,700 patients of Bangladeshi origin were studied, and the sample size was calculated based on statistical power analysis, prevalence estimates from an earlier study, and feasibility aspects, to ensure the sample was representative enough to assess the taurodontism prevalence accurately [11].

Participants were selected using a non-probability convenience sampling technique to ensure feasibility while maintaining a broad representation of the population. The inclusion criteria included adults between 18 and 65 years of age with fully erupted permanent first and second molars, individuals of Bangladeshi ethnicity, subjects with no history of dental diseases, trauma, or congenital anomalies affecting the molars, and participants with either recent radiographic images (Periapical views, Orthopantomogram (OPG), or Radiovisiography (RVG)) to be assessed. Exclusion criteria were individuals with congenitally missing permanent molars. The radiographs were evaluated by endodontists and oral and maxillofacial radiologists to find taurodontism, which is defined as an enlarged pulp chamber with shortened roots. The recorded data contained the prevalence of taurodontism, type of molar (first or second molar, left or right), root morphology characteristics, and demographics (age, sex, and family history of taurodontism) to investigate the possibility of genetic inheritance. Taurodontism was classified based on the Shifman & Chanannel Classification (1978) according to varying degrees of enlargement of the pulp chamber and shortening of roots. Mild taurodontism (Type 1)- some enlargement of the pulp chamber/normal root morphology; moderate taurodontism (Type 2)- further enlargement of the pulp chamber/crown elongation-normal roots; severe taurodontism (Type 3)- marked enlargement of the pulp chamber with hugely shortened roots-gives classic molar 'bull-like' appearance.[11] The analysis of data was performed using IBM SPSS Statistics for Windows, Version 26.0 (IBM, New York, USA). Descriptive statistics were used

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to calculate the prevalence of taurodontism in each group by age, sex, and molar type, thus giving a better insight into the distribution and clinical significance.

Results

Figure 1 illustrates the age distribution of the 2700 participants included in the study.

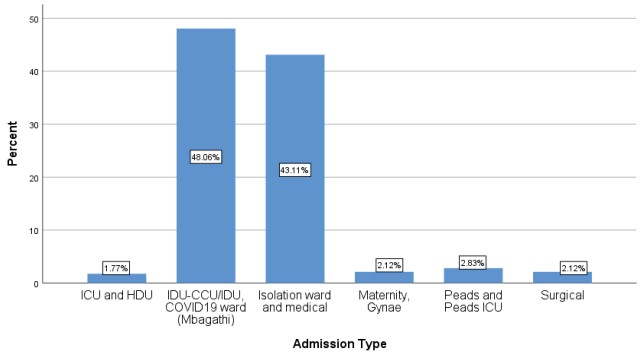

Figure 1: Age distribution of the participants (N = 2700)

The age group most represented falls in the bracket of 26-35 years, with 726 participants, which is 26.9% of the sample. This is followed by the 18-25 age bracket, which is 19.9%, or 537 participants, and the 36-45 age bracket at 19.5%, or 527 participants. The 46-55 age bracket is 17.9% or 483 participants, while the 56-65 age bracket forms the smallest percentage of 15.8% or 427 participants. Figure 2 shows the sex distribution of all the participants included in the study.

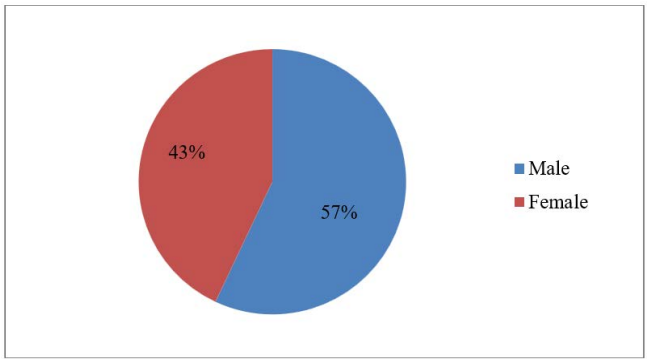

Figure 2: Sex distribution of participants (N = 2700)

Male participants make up 57.0% of the sample, totaling 1539 individuals, while female participants constitute 43.0%, with 1161 individuals. Table I presents the prevalence of taurodontism in permanent first and second molars among 2700 participants.

Of the total sample, 127 cases (4.7%) presented taurodontism in the first molars and 107 cases (4.0%) in the second molars. In total, taurodontism was found in 234 cases, which accounts for 8.7% of the prevalence in this population.

Table I: Prevalence of taurodontism in permanent first and second molars (N = 2700)

Molar Type	Taurodont cases	Prevalence (%)
First molars	127	4.7
Second molars	107	4
Total Cases	234	8.7

Table II: details the prevalence and degree of taurodontism in permanent upper first and second molars among the participants.

Molar type	Degree of taurodontism	Taurodont cases (n)	Prevalence (%)
Upper right first molar (n = 30)	Mild taurodontism	21	70
	Moderate taurodontism	6	20
	Severe taurodontism	3	10
Upper left first molar (n = 27)	Mild taurodontism	22	81.5
	Moderate taurodontism	4	14.8
	Severe taurodontism	1	3.7
Upper Right 2nd Molar (n = 23)	Mild taurodontism	17	73.9
	Moderate taurodontism	4	17.4
	Severe taurodontism	2	8.7
Upper Left 2nd Molar (n = 21)	Mild taurodontism	14	66.7
	Moderate taurodontism	4	19
	Severe taurodontism	3	14.3

Among these, in the upper right first molar (n = 30), 21 cases (70.0%) presented mild taurodontism, 6 cases (20.0%) moderate, and 3 cases (10.0%) severe. In the upper left first molar (n = 27), mild taurodontism had a higher prevalence, occurring in 22 cases (81.5%), with moderate taurodontism in 4 cases (14.8%) and severe in 1 case (3.7%). For the upper right second molar (n = 23), mild taurodontism was present in 17 cases (73.9%), moderate in 4 cases (17.4%), and severe in 2 cases (8.7%). The upper left second molar (n = 21) showed mild taurodontism in 14 cases (66.7%), moderate in 4 cases (19.0%), and severe in 3 cases (14.3%). Table III illustrates the prevalence and degree of taurodontism in permanent lower first and second molars among the participants.

In the lower right first molar (n = 36), 24 cases (66.7%) showed mild taurodontism, with equal prevalence of moderate and severe taurodontism seen in 6 cases each (16.7%). It is also shown in the lower left first molar (n = 34), with mild taurodontism being prevalent in 21 cases (61.8%) of the overall observations, moderate in 8 (23.5%), and severe in 5 (14.7%). Concerning the lower right second molar,

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n = 33 were classified as: 21 of mild taurodontism accounting for 63.6%; 10 or 30.3% moderate taurodontism; and only 2 (6.1%) representing the severe condition. The lower left second molar showed mild taurodontism in 19 cases (63.3%), moderate in 8 cases (26.7%), and in 3 (10.0%) the type was severe, n = 30. Table IV presents the endodontic challenges associated with taurodontism in permanent first and second molars.

In the case of first molars only, 127 cases showed 80.03% or 102 cases with complex root morphology and 40.2% or 51 cases with treatment difficulty. Second molars only accounted for 107 cases, with 70.1%, or 75 cases, showing complex root morphology, while 40.2%, or 43 cases, indicated treatment challenges. In all taurodont cases combined, which is 234 unique cases, 75.6% or 177 cases had complex root morphology, while 40.2% or 94 cases showed treatment difficulty. Table V explores the prevalence of taurodontism in relation to family history, based on self-reported data among the participants.

Among 750 with a positive family history of dental anomalies, taurodontism was found in 14.9% (112 cases). Without a family history, 1700 participants showed a taurodontism prevalence of 5.9% (100 cases). Among participants with unknown family history, 8.8% (22 cases) out of 250 individuals were found to have taurodontism. The overall prevalence of taurodontism across all participants was 8.7% (234 cases). Table VI highlights the unique morphological features of taurodontic molars and their forensic value in distinguishing taurodontic teeth from normal molars.

Of the total cases of taurodontism (234 in number), the pulp chambers of all the taurodontic teeth were enlarged, making that feature a very distinctive mark. An altered crown size and shape, shortened roots, and altered crown root ratio in all the severe taurodont cases (100% of 25 cases); serve as additional identifiers for forensic analysis.

Table III: Prevalence of taurodontism in permanent lower first and second molars (N = 2700)

Molar Type	Degree of taurodontism	Taurodont cases (n)	Prevalence (%)
Lower right first molar (n = 36)	Mild taurodontism	24	66.7
	Moderate taurodontism	6	16.7
	Severe taurodontism	6	16.7
Lower left first molar (n = 34)	Mild taurodontism	21	61.8
	Moderate taurodontism	8	23.5
	Severe taurodontism	5	14.7
Lower right second molar (n = 33)	Mild taurodontism	21	63.6
	Moderate taurodontism	10	30.3
	Severe taurodontism	2	6.1
Lower left second molar (n = 30)	Mild taurodontism	19	63.3
	Moderate taurodontism	8	26.7
	Severe taurodontism	3	10

Table IV: Endodontic implications of taurodontism (Root morphology and treatment complexity)

Molar Type	Taurodont cases	Complex root morphology (%)	Treatment complexity (%)
First molars only	127	102 (80.03%)	51 (40.2%)
Second molars only	107	75 (70.1%)	43 (40.2%)
Total cases	234	177 (75.6%)	94 (40.2%)

Table V: Genetic and familial trends in taurodontism (Self-reported data)

Family history reported	Total	Taurodont cases	Prevalence (%)
Positive family history	750	112	14.9
No family history	1700	100	5.9
Unknown	250	22	8.8
Total	2700	234	8.7

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Table VI: Forensic implications - taurodontism as an identifiable feature

Features of taurodontic permanent first and second molars in comparison to normal	Total cases	Percentage identified as distinctive
Enlarged pulp chamber	234	100%
Altered crown size and shape in severe taurodontism (n = 25)	25	100%
Shortened roots in severe taurodontism (n = 25)	25	100%
Altered crown root ratio in severe taurodontism (n = 25)	25	100%

Discussion

The findings from this study on taurodontism in the Bangladeshi population align with previous studies done in other populations, emphasizing taurodontism's implications across genetics, forensic odontology, and endodontics. Our findings align with reports from Nigeria, Turkey, China, and other regions, suggesting taurodontism's varied prevalence and potential genetic association across populations [2,4,7,17,18,19,20,21,24,25]. Comparative studies, such as those by Yemitan and Adediran in Nigeria and Çakıcı et al. in northern Anatolia, reveal that taurodontism prevalence varies considerably by region, likely influenced by genetic factors and possibly environmental conditions [17]. Yemitan and Adediran found a prevalence of 5% in mandibular molars. Similarly, Çakıcı and colleagues showed comparable rates among Turkish populations. These figures are slightly lower than the 8.7% prevalence found in our study among the Bangladeshi population, which suggests there is some regional variation that may be due to genetic background or possibly due to specific characteristics in this population. A remarkably high prevalence of taurodontism in North China was thus reported, suggesting that specific regional genetic factors may be responsible for the higher expression of this trait [17,18]. Similarly, Shah et al., found a 4.2% prevalence in an Indian subpopulation, indicating that the trait is relatively rare but still significant in South Asian populations [19]. This variance in prevalence underlines the need to consider taurodontism in regional contexts for a better understanding of genetic influences and the formulation of dental approaches. Our findings are in agreement with those of Shifman & Chanannel, who found a 5.6% prevalence among an Israeli population, with the mandibular second molar being the most commonly affected, thus reinforcing the genetic and morphological patterns seen in different populations [11].

Taurodontism is often linked with certain genetic conditions, further indicating that genetic inheritance may influence its prevalence [20]. Kan et al., demonstrated an association between taurodontism and hypodontia, suggesting that dental anomalies often co-occur due to shared genetic pathways [20]. Likewise, Poornima et al., observed taurodontism in individuals with hypodontia, reinforcing the theory of a genetic link between these traits [21]. In our study, the higher prevalence of taurodontism in subjects with a family history of dental anomalies is in agreement with observations made by Kan et al. and others. This familial tendency would indicate that taurodontism can be used as a phenotypic marker in diagnosing genetic disorders, especially when associated with other dental anomalies. For instance, Andersson et al., included taurodontism as one of the minor criteria in the diagnosis of syndromes such as Laurence-Moon-Bardet-Biedl, suggesting taurodontism may have a diagnostic significance in certain syndromic situations [22].

The altered morphology of taurodont presents considerable challenges in endodontic procedures, as highlighted by Bharti et al. and Bürklein et al.[23,24] Bharti and colleagues emphasized the difficulty in accessing the pulp chamber and filling root canals due to the larger chamber size and altered root structure [23,24]. Bürklein et al. echoed these challenges in their study on taurodontdal molars, noting the complexity of root canal treatments and the necessity for advanced endodontic techniques to manage such cases [24]. More than 75% of the taurodontic molars constituted complex root morphology, while about 40% constituted the challenging-to-treat form in our Bangladeshi sample. The high treatment complexity ratio agrees with earlier reports, hence the emphasis on special training and strategies for dealing with the condition, which may be prevalent in certain populations. From the forensic aspect, taurodontism is one of the morphologic features that will aid in personal identification, especially in cases of limited dental record availability. MacDonald-Jankowski and Li, while working on young adult Chinese, reported the feature of taurodontism with a typical appearance and its application in forensic odontology [25]. In our study, taurodontic teeth exhibited unique features like enlarged pulp chambers, altered crown shapes, and fused roots, which could serve as identifiers in forensic examinations. Our findings highlight the high prevalence of these characteristics among taurodontic cases, making them distinctive for dental identification. The forensic applicability of taurodontism is also supported by findings from Shah et al., who emphasized its value in distinguishing individuals based on unique dental morphology [19]

The study's cross-sectional design limits the ability to establish causal relationships between taurodontism and genetic or environmental factors. Reliance on self-reported family history data may introduce recall bias, potentially

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affecting the accuracy of genetic association findings. The sample was drawn from the Department of Conservative Dentistry and Endodontics, Sapporo Dental College and Hospital, Dhaka, which may not fully represent the prevalence of taurodontism across the entire Bangladeshi population. Thus, in the future, larger and more diverse samples, including genetic testing, may be able to shed more light on the inheritance patterns of taurodontism. On the other hand, although radiographic imaging is a very reliable diagnostic modality in the diagnosis of taurodontism, advanced imaging techniques, such as CBCT, may provide further details about root morphology that may be useful in endodontic and forensic applications.

Conclusion

This study on taurodontism prevalence in the Bangladeshi population contributes to the growing body of knowledge on this dental anomaly and reinforces findings from various international studies. The relatively high prevalence of taurodontism among Bangladeshi individuals, its association with genetic factors, and its endodontic and forensic implications highlight the necessity for further research and specialized training. Through a deeper understanding of taurodontism's genetic underpinnings and clinical challenges, dental professionals can enhance patient care and improve identification methods in forensic science.

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