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Prevalence of Taurodontism in a Tertiary Hospital in Ghana

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Abstract

Background: Taurodontism is one of the most significant deviations from the normal tooth morphology affecting the molars in both primary and permanent dentition. Taurodontism refers to the Enlargement of the pulp chamber, resulting in its bifurcation pushed toward the apex of a tooth's root. This study evaluated the prevalence of Taurodontism from radiographs taken at the University of Ghana Dental School Oral Radiology Unit from January 2017 to December 2022. **Methodology:** In this cross-sectional study, panoramic and periapical radiographs of 1000 randomly selected patients who visited the Oral Radiology Unit from January 2017 to December 2022. Radiographs were evaluated for apically displaced pulp chamber. Data was statistically evaluated, and the chi-square test was employed to assess the prevalence of taurodontism in the upper and lower jaws ($p < 0.05$). **Results:** Taurodontism was found in 171 radiographs giving it a prevalence of 17.1% of which 57% (98 radiographs) were from females and 43% (73 radiographs) were from males. This finding was not significant ($p > 0.05$). Taurodontism occurred more in the maxilla (289 teeth, 80.7%) compared to the mandible molars (186 teeth, 64.3%) giving it a ratio of 1.6:1. This finding was highly significant ($p < 0.001$). The distribution of the different types of taurodonts differed in both jaws. According to the morphology, mesotaurodonts were most common in both jaws (132 and 78 in the maxilla and mandible respectively). **Conclusion:** Taurodontism is relatively common in the Ghanaian population affecting more females compared to males according to this study. Further studies using a large sample need to be carried out to determine its incidence in the general community.

Keywords

Taurodontism, Prevalence, Maxilla, Mandible, Molar Teeth

1. Introduction

Dental developmental problems could result from anomalies in dental lamina differentiation, which could result in variations in quantity, magnitude, and form of the dental lamina, or from anomalies in the formation of the dental hard tissues, which could result in variations in the structure of the dental hard tissues. Amelogenesis imperfecta, Dentinogenesis imperfecta, hypodontia, hyperdontia, fusion, germination, microdontia, hypodontia, and other anomalies are among the possible outcomes of the defects.

One of the most notable variations from typical tooth form is Taurodontism. Taurodontism is described as an expansion of pulp chambers and the displacement of the furcation area toward the apex of a tooth's root [1]. The expression was used to illustrate how the pulp chamber's vertical development resembles the arrangement of teeth found in cattle. This pattern of molar teeth development, which has been noted in ancient Neanderthals, is known by the names "tauro" (bull) and "dont" (tooth) [2].

It was discovered among the earliest *Homo sapiens neanderthalensis* communities and was thought to be linked to thin enamel. Following the discovery of fossilized members of the Neanderthals at Krapina in Croatia in 1899, interest in these types of molars first gained traction. The Krapina Neanderthal fossils have a high prevalence of taurodontism, and the oldest Krapina specimen with taurodontism is a 70,000-year-old anthropological specimen [3]. Their findings further showed that, despite a large disparity in the incidence of this characteristic due to ethnic variances and various variables used to interpret this trait, taurodontism has been reported to affect fewer than five percent of individuals in modern countries. This finding confers some biomechanical advantages for withstanding and distributing the occlusal loadings produced during the chewing cycle [4]. Other hypotheses claimed that external influences could be ascribed to the pathogenesis of this aberration, as the theory that taurodontism was pre-historically beneficial for people to permit heavy masticatory habits was not confirmed [5].

The aetiology of taurodontism is unclear. The following is a list of Mangion's suggested causes for taurodontism: During the Dentinogenesis of the roots, five different mutations might occur: 1) a specialised or retrograde character, 2) a primitive pattern, 3) a Mendelian recessive trait, 4) an atavistic characteristic, and 5) a mutation caused by odontoblastic insufficiency [6].

A disruption in the Hertwig's epithelial root sheath (HERS), which provides the first framework for the root's architecture, is thought to be the aetiology of taurodontism. The creation of the pulp chamber is disrupted as a result of a de-

lay in root invagination or failure at the site where the many roots of teeth meet, which can cause taurodontism and other morphological anomalies. This vertical elongation of the pulp chamber of the teeth below the cementoenamel junction (CEJ) has been described to occur either as an isolated condition or in association with dental malformations and developmental syndromes, and it may be a marker of orofacial illnesses. There have been reports of links between taurodontism and amelogenesis imperfecta, dens invaginatus, microdontia, and dermatological conditions [5].

Another potential aetiology is interference with the induction of epitheliomesenchymatose. According to some accounts, taurodontism may be genetically inherited and may be linked to an excess of X chromosomes. On the other hand, other researchers could not discover a straightforward genetic relationship but did see a tendency for X chromosomal aneuploidy among patients with more severe manifestations of the characteristic [7]. Taurodontism has been connected to the X-chromosome polyploidy found in the Finnish population, including 47XXX, 48XXXX11, and 47XXY [5]. Each additional X-chromosome was found to be associated with an increasing trend in severity [8].

Taurodontism comes in a variety of forms, some with and others without syndromes, like many other dental developmental disorders which include Aperts syndrome, Down's syndrome, Focal dermal hypoplasia (also known as Goltz Gorlin syndrome), Ectodermal dysplasia, and Amelogenesis imperfecta are a few examples of syndromes linked to taurodontism. oligophrenia, taurodontism, and hypophosphatasia microdontia, microdontia-taurodontia-dens invaginatus, and microcephalic dwarfism-taurodontism Eye, dental, and digital dysplasia Type II oral-facial-digital Rapp-Hodkin syndrome, congenital dyskeratosis, Tricho-dento-osseous syndrome, Mohr syndrome, Klinefelter syndrome Lowe syndrome, Smith-Magennis syndrome, Williams syndrome, McCune-Albright syndrome, Van der Woude among others [8].

Additionally, compared to the population that is thought to be normal, patients with Down syndrome have a higher frequency of taurodontism [5].

The molars in both the permanent and deciduous dentition are the most commonly affected teeth [3].

Based on the level of severity, Taurodontism is classified into three types, *i.e.*, hypotaurodontism, mesotaurodontism, and hypertaurodontism [2].

The global prevalence of taurodontism ranges between 2% to 48% [6]; most studies take into account both the prevalence of taurodontism in patients and individual teeth. While some studies focused on evaluating periapical radiographs, others examined the prevalence of taurodontism as seen on panoramic radiographs and cone beam computer tomography (CBCT).

The prevalence of taurodont molars has reportedly been documented in a variety of populations [5]; the highest prevalence of taurodontism was found in Brazilian (43%), Israeli (33.6%) (6% in earlier (1978) Israelis) and Chinese (44%) communities, with Turks and Iranians having a moderately higher prevalence

(11% and 23%, respectively), and Germans having the lowest prevalence ranging 0.6% to 2% [7].

In Africa, the prevalence of taurodontism in the Senegalese population was found to be 48% [8]. Another study in Egypt reported a prevalence of 0.6% [9]. Studies on 197 randomly selected orthopanthomographs of patients attending a Specialist Dental Clinic in Lagos, Nigeria, came out with a 19.1% mandibular molar taurodontism prevalence and a 33% people prevalence [10].

Taurodontism can occur unilaterally or bilaterally in both the maxilla and mandible [5] [11]. Some studies showed females were more affected [5] [11]. However, another showed a male preponderance in the Egyptian population [9].

As of the current date, no study has been conducted to investigate the prevalence of taurodontism within the Ghanaian population. The purpose of this study is to examine the prevalence of taurodontism in patients who have sought dental services at the University of Ghana Oral Radiology Unit.

1.1. Aim

This study aimed to evaluate the prevalence of taurodontism amongst patients visiting the University of Ghana Dental School Oral Radiology Unit using measurements from panoramic and periapical radiographs.

1.2. Specific Objectives

The specific objectives of the project were:

1) To determine the overall prevalence of taurodontism among patients visiting the University of Ghana Dental School Oral Radiology Unit.

2) To identify the most common type of taurodontism among patients visiting the University of Ghana Dental School Oral Radiology Unit.

3) To identify the jaw most affected by taurodontism among Ghanaian dental patients.

4) To investigate the demographic characteristics of those commonly affected in the Ghanaian population.

2. Methodology

2.1. Study Design

This was a quantitative study, consisting of a retrospective assessment of randomly selected radiographs of patients who presented at the Radiology Unit of the University of Ghana Dental School for treatment from January 2017 to December 2022.

2.2. Study Area

The study was conducted at the Radiology Unit of the University of Ghana Dental School, Korle Bu. Established in 1992, the University of Ghana Dental School is the first dental school to be established in Ghana. It is located within the Ablekuma locality of Accra Metropolis, in the Greater Accra region of Ghana.

2.3. Study Population

The study involved a review of radiographs of patients who presented at the Radiology Unit of the University of Ghana Dental School from January 2017 to December 2022.

2.4. Inclusion Criteria

All patients who had Panoramic and periapical radiographs taken at the University of Ghana Dental School between January 2017 and December 2022.

2.5. Exclusion Criteria

1) Patients whose records were not completely documented will not be encompassed in this study.

2) Third molars, impacted teeth with low radiographic quality, fused roots, and unrecognisable furcation sites.

3) Permanent molars with root canal treatment, fractured molars, deep carious or repaired molars, inadequate root development, and molars with a bonded orthodontic appliance.

2.6. Sample Size Calculation

With a 95% confidence level, a p-value of 0.336 (regarding a similar study done in Israel) and a 0.05 d value, the formula $N = Z^2 \times p\,(1 - p)/d^2$ was used to determine the sample size for this investigation:

$N = [(1.96)^2 \times (0.336) \times (1 - 0.336)]/(0.05)^2$.

$N = 343$ radiographs.

However, 1000 radiographs were used instead of 343 radiographs.

2.7. Sampling Method

A systematic random sampling method was used to select the participant radiographs for this study. Therefore, the documented radiographs were chosen from January 2017 to December 2022.

2.8. Data Collection Techniques/Methods and Tools

Data was collected as softcopy radiographs with a storage device (external hard disk drive), from the University of Ghana Dental School Radiology Unit, arranged according to years and months. The radiographs were then examined and classified using the Shiffman and Chananel Criteria [6] to detect which teeth were taurodonts and to further classify them into the various types of taurodonts.

2.9. Data Analysis

The study used Microsoft Excel 2016 and SPSS for data analysis, coding and exporting data after collection. Data was summarized as means and standard deviations for normally distributed variables and median and interquartile ranges

for skewed ones. Categorical variables were summarized as frequencies, proportions, or percentages. Proportions were compared using a chi-square test and a significant level set at alpha = 0.05.

2.10. Ethical Considerations

Ethical clearance was obtained from the Ethical Review Board of the College of Health Sciences, University of Ghana.

3. Results

3.1. Prevalence of Taurodontism

From Figure 1, the prevalence of taurodontism in patients who attended the University of Ghana Dental School Clinic and underwent radiographic examinations between January 2017 and December 2022 is 17.1%.

3.2. Sex Distribution

A total of 171 of the 1000 radiographs assessed in this study, had taurodont teeth. Table 1 shows the sex distributions. This consisted of males (42.7%) and females (57.3%), representing a ratio of 1:1.3 (M:F).

3.3. Jaw Distribution

Table 2 shows the presence of taurodonts in the maxilla. Maxillary taurodonts were present in 138 radiographs with a total of 289 taurodont teeth (80.7% of all radiographs with taurodonts).

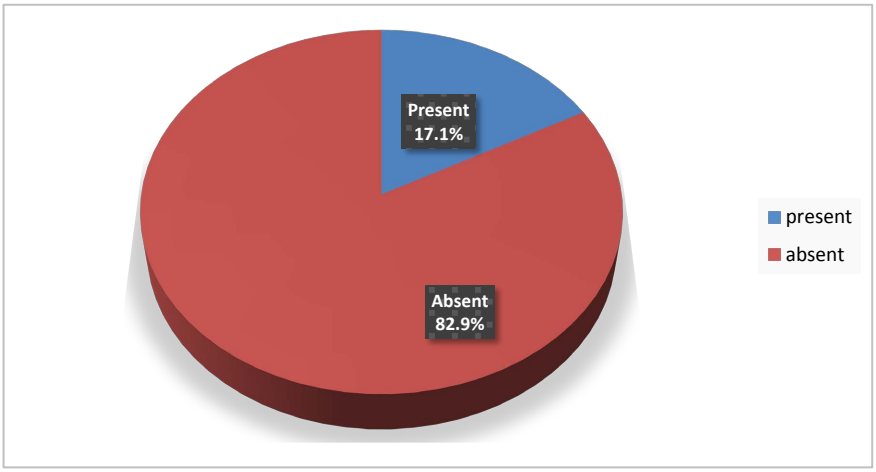

Figure 1. Prevalence of taurodontism.

Table 1. Sex distribution of patients with taurodonts.

Sex	Frequency (n)	Percentage (%)	*p*-value
Male	73	42.7	
Female	98	57.3	0.388
Total	171	100	

Table 2. Presence of taurodonts in the maxilla.

Presence of Taurodont	Frequency (n)	Percentage (%)
Absent	33	19.3
Present	138	80.7
Total	171	100

3.4. Presence of Taurodonts in the Mandible

Table 3 shows the presence of taurodonts in the mandible. Mandibular taurodonts were present in 110 radiographs with a total of 186 taurodont teeth (64.3% of all radiographs with taurodonts).

3.5. Number of Taurodonts

Figure 2 shows the distribution of taurodonts (number of teeth) in both jaws. A total of 475 taurodonts were found in both jaws, with 186 teeth in the mandible and 289 teeth in the maxilla. Mesotaurodonts had the highest frequency (210 teeth), followed by hypertaurodonts (147 teeth) and with the least frequency hypotaurodonts, with a frequency of 118 teeth.

3.6. Type of Taurodont

Figure 3 shows the distribution of the types of taurodonts in the maxilla; there were 54 hypotaurodonts (19%), 103 hypertaurodonts (35%), and 132 mesotaurodonts (46%).

3.7. Distribution of Types of Taurodonts in the Mandible

Figure 4 shows the distribution of the types of taurodonts in the mandible; there were 64 hypotaurodonts (34%), 44 hypertaurodonts (24%), and 78 mesotaurodonts (42%).

4. Discussion

4.1. Prevalence of Taurodontism

The overall prevalence of taurodontism was 17.1% of all radiographs investigated. This was less than studies done in Israel (33.6%), North-West China (29.1%), Türkiye (22.8%), Iran (22.9%), Senegal (48%) and Nigeria (33%) [5] [12] [13] [14] [15] [16].

However, the prevalence was higher compared to studies done in Egypt (0.6%) and India (11.8%) [9] [16].

This wide variation in the stated prevalence of taurodont molars could be due to racial disparities and geographical location across various study populations. Also, genetic factors might contribute to these differences.

Furthermore, the omission of third molars or the incorporation of premolars can all be attributed to the wide variation in the prevalence in some reports although the same Shifman and Chanannel's classification was used.

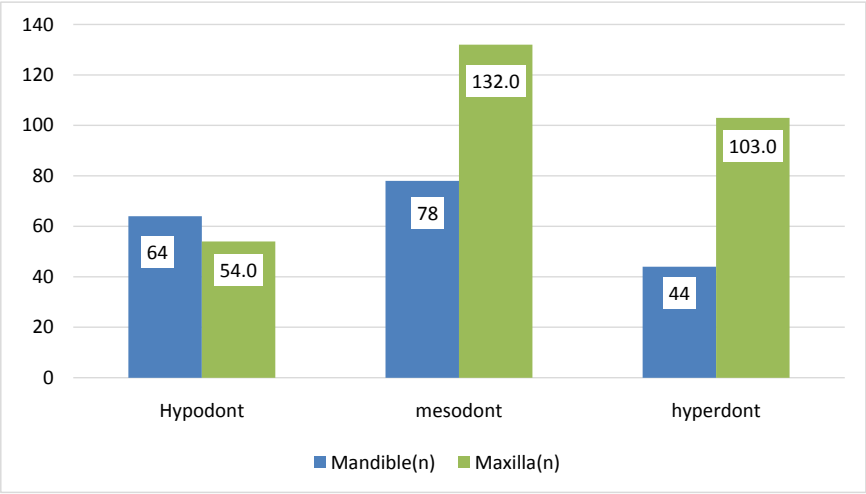

Figure 2. Number of taurodonts in the maxilla and mandible.

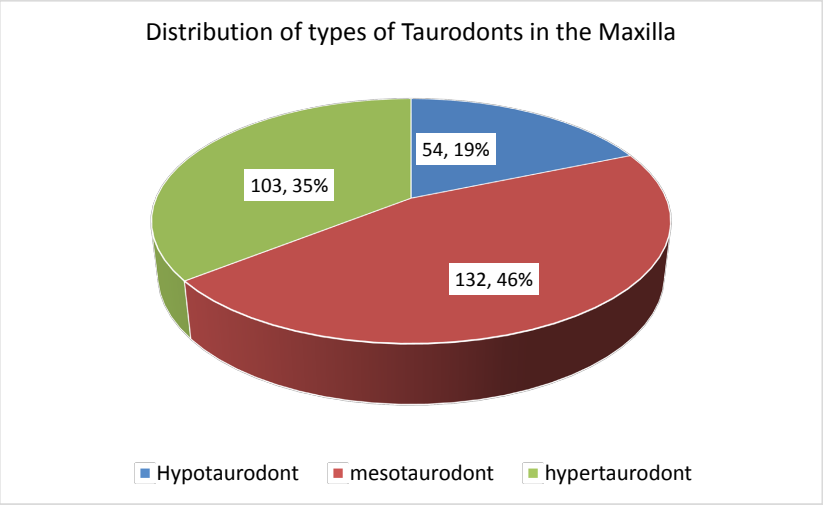

Figure 3. Distribution of types of taurodonts in the maxilla.

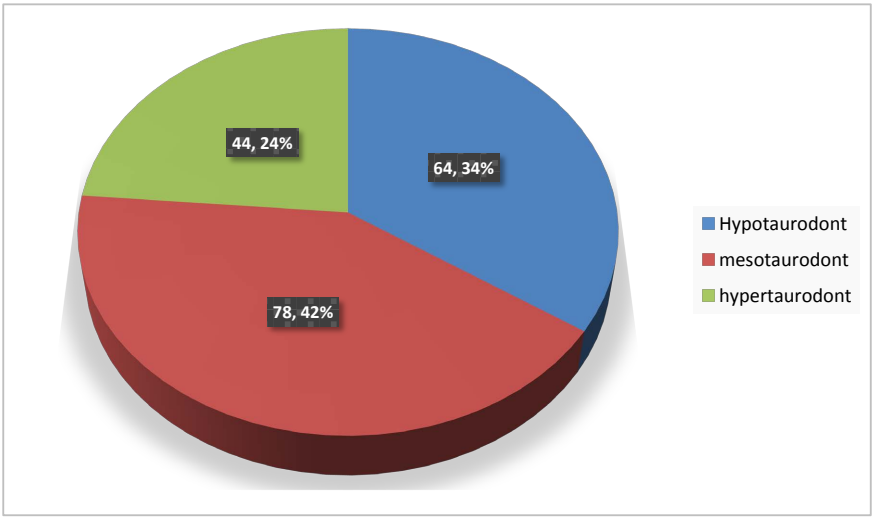

Figure 4. Distribution of types of taurodonts in the mandible.

Table 3. Presence of taurodonts in the mandible.

Presence of Taurodonts	Frequency	Percentage (%)
Absent	61	35.7
Present	110	64.3
Total	171	100

The sample size, sampling method and duration of studies can have a substantial influence on prevalence outcomes. Prevalence rates might exhibit an inclination to be higher in studies with smaller sample sizes when contrasted with those employing larger sample sizes.

4.2. Sex Distribution

In this study, there were more females (57.3%) with taurodontism compared to males (42.7%). This research supports studies done in North-West China [17] where 58.6% of patients with taurodonts were females and 41.4% of patients with taurodonts were males, and studies done in Israel (52% females vs. 48% of males) [5].

The similarities in findings could be attributed to the hypothesis linking taurodontism with the X chromosome [18], potentially resulting in a greater prevalence among females as compared to males.

In addition, studies suggest women have greater oral health awareness and more positive views concerning dental appointments compared to men [19], hence, dental anomalies can be frequently detected more in females than in males.

Contrary findings have been documented in separate studies. A study in Egypt revealed a greater prevalence among males (66.7%) compared to females (33.3%) [9]. This variance could potentially be attributed to the relatively low occurrence of taurodontism within the study population, particularly when juxtaposed with the considerable sample size.

Hormonal influences as well as genetics and racial disparities may affect the prevalence in males and females.

There was no statistical significance between male and female distribution ($p > 0.05$). This finding was consistent with the study in North-West China [12].

4.3. Jaw Distribution

In this study, 186 taurodonts were observed in the mandible (constituting 39.2%), while 289 taurodonts were noted in the maxilla (making up 60.8%). These findings are similar to a study conducted in North West China [17] wherein a higher prevalence of maxillary taurodonts compared to mandibular taurodonts was observed (71.6% vs. 28.4%). A similar trend was also identified in a study carried out in Türkiye [15], wherein maxillary molars displayed the highest prevalence. This occurrence could be attributed to the accuracy of measurements used in this study as well as the classifications used.

In contrast, another study done in South Iran demonstrated a greater prevalence in the mandible when compared to the maxilla (52.1% vs. 47.9%) [11]. These disparities in outcomes may arise from variations in the sequences of tooth development between the mandible and maxilla, as well as potential racial differences.

Statistical significance was evident in the prevalence of taurodontism between the maxilla and mandible ($p < 0.001$).

4.4. Type of Taurodontism

In this study, the prevailing type of taurodontism observed, both in the maxilla and mandible, was mesotaurodontism, characterized as the moderate form, constituting a prevalence of 44.2%. Subsequently, hypertaurodonts were noted with a prevalence of 30.9%, while the least frequent was hypotaurodontism, accounting for a prevalence of 24.9%.

This study is contrary to earlier findings which reported the highest occurrence of hypotaurodonts 60.39%, 84.1% and 94% in North West China, Iran and Ashkelon Israel respectively [5] [17] [20].

These disparities in results might stem from distinctions in tooth developmental processes and genetic influences. Additionally, epigenetic factors could contribute to the variations in the types of taurodontism observed among patients.

Furthermore, statistically significant variations were evident in the prevalence of the different types of taurodontism ($p < 0.001$).

4.5. Study Limitations

1) Several radiographs proved to be inaccessible due to the presence of missing data, rendering them unattainable for analysis and evaluation.

2) The radiographs stored were devoid of crucial patient demographics, thereby rendering the study notably more challenging than its intended level of complexity.

5. Conclusion and Recommendations

5.1. Conclusion

This study revealed a notable discovery wherein a substantial proportion of patients visiting the University of Ghana Dental School Clinic presented taurodont teeth, with a higher prevalence observed among females in comparison to males. The majority of these occurrences were found in the maxillary region, with the mesotaurodont type being particularly prominent. Consequently, it is of utmost importance for dental practitioners in this geographical area to be vigilant for the presence of taurodont teeth during their clinical practices. This awareness is essential to provide appropriate care and pre-empt potential complications associated with this dental anomaly.

5.2. Recommendations

1) For enhanced precision in measurement, the utilization of cone beam radiographs could be considered for future research initiatives of taurodontism.

2) Given the substantial number of lost radiographs, it is advisable to establish a cloud-based backup system as a precautionary measure. This cloud repository would serve as a secure and reliable safeguard, ensuring the preservation and protection of the radiographic data in the event of any potential corruption or loss on the computer or hard disk drive.

3) Facilitate seamless radiographic assessment for research endeavours by diligently storing radiographs alongside comprehensive patient demographic information.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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