ANALYSIS OF THE OCCURRENCE OF TAURODONTISM IN PATIENTS ATTENDING THE TYGERBERG ORAL HEALTH CENTRE

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A mini-thesis submitted in partial fulfilment of the requirements for the degree of Magister Scientiae in the Department of Maxillofacial Radiology of Dentistry, University of the Western Cape.

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KEYWORDS

Taurodontism

Occurrence

Panoramic Radiographs

Taurodont teeth

Diagnosis

Classification

ABSTRACT

Aim: Analysis of the occurrence of taurodont molars among patients attending the Tygerberg Oral Health Centre.

Methodology: A retrospective descriptive study comprising 1608 panoramic radiographs of patient records, 815 females and 793 males, ranging in ages from 18 to 68 years old. The panoramic radiographs were evaluated for presence of taurodontism. Gender predilection and location of taurodont molars were analysed using a chi-square test.

Results: Taurodontism was found in 52 (3.23%) radiographs distributed according to gender (30 females and 22 males [P > 0.05]). The overall prevalence of taurodont molars was (0.73%) from a total of 17148 molars that were examined. The mandibular molar teeth were more affected than the maxillary molar teeth and the second mandibular tooth was the most affected.

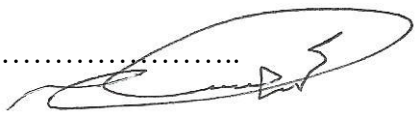
Conclusion: Taurodontism was not uncommon in a group of patients that attended the Tygerberg Oral Health Centre, UWC. Further larger scale studies are required to assess its distribution in the general population of South Africa to compare it with other ethnic groups and to establish any associations. However, taurodontism in mandibular teeth is a condition that should be taken into consideration, especially the second mandibular tooth, to avoid complications.

DECLARATION

I declare that *An analysis of the occurrence of taurodontism in patients attending the Tygerberg Oral Health Centre* is my own work, that it has not been submitted for any degree or examination at any other university, and that all sources I have used or quoted have been indicated and acknowledged by complete references.

Mohamed Benzahya October 2015

Signed ……..



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LIST OF ABBREVIATIONS

CEJ: Cement-Enamel junction

CB: Crown-Body length of the tooth

R: Root length of the tooth

TI: Taurodontism Index established by Shifman and Chanannel (1978)

T: Taurodontism

OHC: Oral Health Centre

UWC: University of Western Cape

Chapter 1

INTRODUCTION

Taurodontism is one of the anomalies of tooth morphology encountered in the dentition. This anomaly is a developmental disorder of a tooth that shows a lack of constriction at the cement-enamel junction (CEJ) and is characterized by vertically elongated pulp chambers, apical displacement of the pulpal floor and bifurcation or trifurcation of the roots (Hargreaves and Goodis 2002; Neville *et al*. 2002).

Early anthropological studies of Croatian Neanderthal samples dating back 70000 years showed signs of taurodontism (Barker, 1976; Keith, 1913).

In the early 1900`s, Pickerill noted a difference in tooth form of peculiar human dentitions in certain patients. He made no attempt to label this alteration.

In 1913, taurodontism was first described by Keith as: a tendency for the body of the tooth to enlarge at the expense of the roots.

The origin of the name taurodontism is a combination of the two words “tauros”, meaning “bull” in Latin and “odus” which is of Greek origin meaning “tooth" and the initial use of the term, taurodontism, was to describe molar teeth resembling those of ungulates, particularly bulls (Witkop, 1976). Taurodontism is currently defined as tooth morphologic alterations with the absence of the usual constriction at the cemento-enamel junction; apical shift of the pulp chamber floor and furcation area at the expense of the roots and the root canal length (Witkop, 1971).

Taurodontism can complicate certain procedures for the dentist during extraction and endodontic, orthodontic and/or prosthetic treatment planning (Ghabanchi *et al*. 2010).

There is a lack of literature on the prevalence of taurodontism in South Africa, bearing in mind that South Africa is a country of diverse ethnic affiliations with varying representation.

To date, international studies have focused on the prevalence of taurodontism and very few have focused on the location and the exact teeth that can be affected as well as the prevalence between genders. This study attempts to address the prevalence of taurodontism in a diverse population, the gender differences and isolating the most affected teeth.

Chapter 2

LITERATURE REVIEW

2.1 The etiology and the pathogenesis of taurodontism

The etiology of taurodontism is still unclear. Some studies suggested that it results from the invagination failure of Hertwig`s sheath at the proper horizontal level (Reichart and Quast 1975; Hamner *et al*. 1964).

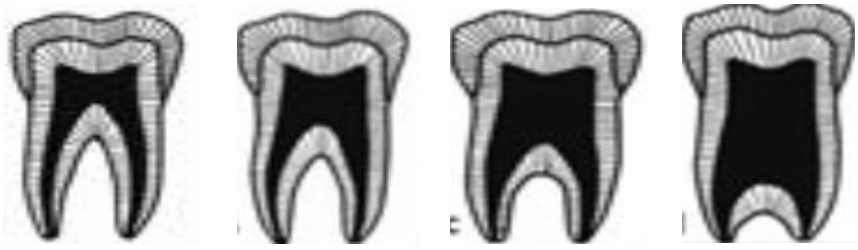
Llamas and Jimenez-Planas (1993) suggested that the interference in epithelial-mesenchymal induction can be considered a possible cause of taurodontism. Other theories that have been postulated include: a primitive pattern, a mutation, a retrograde or specialized character, an X-linked trait, familial or an autosomal dominant trait (Bhat *et al*. 2004), while some authors suggest that Taurodontism is due to an ectodermal abnormality (Darwazeh *et al.* 1998). Numerous theories have been proposed that the condition is related to genetic factors or mutations (Witkop, 1971; Goldstein, 1973; Constant and Grine 2001). Taurodontism seems essentially an isolated anomaly, but has been implicated to occur in association with certain syndromes and genetic disorders that affect tooth morphogenesis, namely: Ectodermal dysplasia; Down's syndrome; McCune-Albright syndrome; Williams's syndrome; Amelogenesis imperfecta; Klinefelter syndrome; Lowe syndrome; Wolf-Hirschhorn syndrome; and Mohr syndrome (Joseph, 2008; Axelsson *et al*. 2003; Akintoye *et al*. 2003; Andersson *et al*. 2013).

2.2 The Diagnosis and Classification of taurodontism

Clinically, taurodont teeth cannot be diagnosed because the CEJ and roots of a taurodont tooth lie below the alveolar margin, (Terezhalmy *et al*. 2001; White and Pharoah 2004). Therefore, the diagnosis of taurodontism is usually made from diagnostic radiographs (Neville *et al*. 2002). Taurodontism can be seen in both the permanent and primary teeth but considered rare in the primary dentition (MacDonald-Jankowski and Li 1993; Goaz and White 1994; Darwazeh *et al*.1998; Terezhalmy *et al*. 2001; Neville *et al*. 2002; Bhat *et al*. 2004; Rao and Arathi 2006).

Shaw (1928) classified taurodontism as hypotaurodontism, mesotaurodontism and hypertaurodontism based on the relative displacement of the floor of the pulp chamber:

- **Hypotaurodont:** moderate enlargement of the pulp chamber at the expense of the roots.
- **Mesotaurodont:** pulp is quite large and the roots short but still separate.
- **Hypertaurodont:** prismatic or cylindrical forms where the pulp chamber nearly reaches the apex and then breaks up into 2 or 4 channels.



Normal molar tooth | **Hypotaurodont molar tooth** | **Mesotaurodont molar tooth** | **Hypertaurodont molar tooth**

Figure1: Shaw Index of taurodontism classification.

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 (Gupta and Saxena 2013). 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 (Constant and Grine 2001). Keene (1966) suggested a taurodont index that calculates the relation between the height of the pulp chamber and the length of the longest root. He proposed three categories of taurodontism for this index: Normal teeth: index value of 0–24.9%; Hypotaurodont teeth: index value of 25–49.9%; Mesotaurodontism: index value of 50–74.9%; Hypertaurodontism: index value of 75–100%. The 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.

Feichtinger and Rossiwall (1977) based the diagnosis of taurodontism on the distance from the bifurcation or trifurcation of the root to the CEJ, which should be longer than the occluso-cervical distance.

A biometric study conducted by Blumberg *et al*. (1971) used five variables to diagnose taurodontism, without specific reference to any classification. 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.

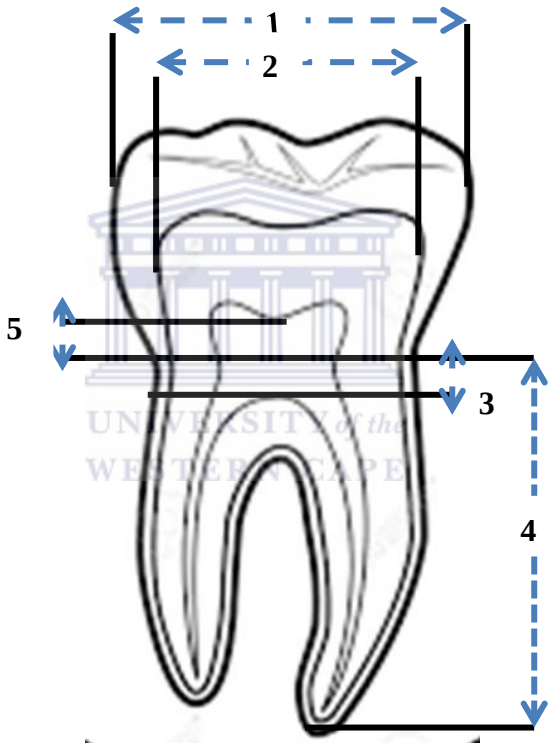


Fig 2 Showing Blumberg variables of taurodontism classification.

The biometric technique advised by Seow and Lai (1989) 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.

Shifman and Chanannel (1978) proposed a new classification derived from a taurodontism index (TI), calculated by measuring two variables of molar teeth on radiographs:

Variable 1: This is the distance between the lowest point of the roof of the pulp chamber and the highest point in the floor of the pulp chamber.

Variable 2: This is the distance between the lowest point of the roof of the pulp chamber and the apex of the longest root.

Variable 3: The distance between a line connecting both CEJ points, and the highest point of the floor of the pulp chamber.

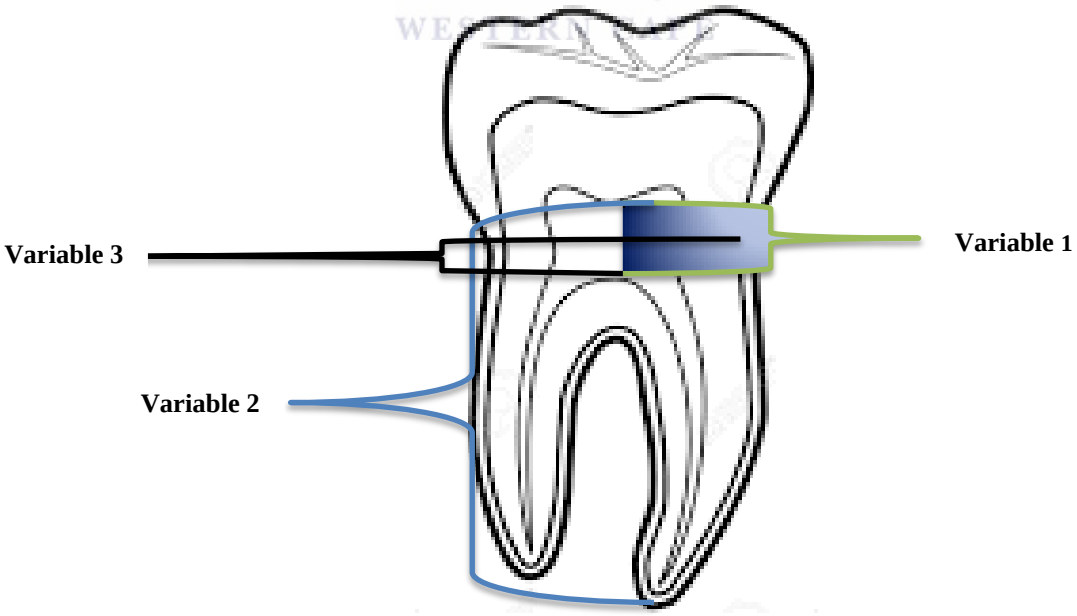


Figure 3: Showing the three variables used in the Shifman and Chanannel classification.

Variable 1 and 2 are used to calculate the taurodontism Index (TI) as follows:

$$\text{TI} = \frac{\text{variable1}}{\text{variable2}} \times 100$$

Taurodont molar teeth were diagnosed when the TI was above 20 and variable 3 measured more than 2.5 mm. By using the taurodontism index TI, the degrees of taurodontism were classified as: hypotaurodontism has a TI from 20 to 30, mesotaurodontism has TI from 30 to 40, while a TI from 40 to 75 presents hypertaurodontism. This is regarded as the most widely used system to date (Shifman and Chanannel 1978).

In addition to all these methods, Tulensalo *et al*. (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 epidemiologic investigations for assessing taurodontism in a developing dentition (Sarr *et al*. 2000; Topcuoglu *et al*. 2011).

2.3 Prevalence of taurodontism

Studies on the prevalence of taurodontism have been carried out on a global scale, and range between 2 and 48%. Most studies consider the prevalence of taurodontism in patients as a whole, as well as individual teeth. Some studies examined the prevalence of taurodontism as diagnosed on panoramic radiographs (extra oral) while others focused their study on evaluating periapical and bite wing radiographs (intra oral).

Prevalence of tuarodontism in a German study was 2.25% in a sample size of 800 patients, with a higher incidence in females. The study was conducted using intra oral radiographs (Bürklein *et al*. 2011). In a similar study in India, the prevalence was reported as 2.5% with a female preponderance. This study was also conducted using intra oral radiographs and reported a 1.21% incidence amongst molar teeth with the maxillary second molars being the most affected (Gupta and Saxena 2013).

A Prevalence of 4.79% was recorded in a biometric study performed in a Trinidadian population for taurodontism in premolars on periapical as well as panoramic radiographs. A higher male rather than female prevalence was observed and also a significant differences between maxillary and mandibular premolars (Pillai *et al.* 2007). An 8% prevalence was reported in a Jordanian population and 4.4% incidence of all molar teeth assessed, in a study using intraoral radiographs. No significant gender difference was observed (Darwazeh *et al*. 1998). In a study of Saudi dental patients, a prevalence of 11.3% was reported by Ruprecht *et al*. (1987) who used both panoramic as well as periapical radiographs. They also found no significant difference amongst the different genders.

Shifman and Chanannel (1978) reported a 5.6% prevalence among the Israeli dental subjects on periapical radiographs with a slightly higher frequency in females. They also reported a 1.5% incidence of molar teeth studied. In a study observing 510 panoramic views in the South of Iran, taurodontism was present in 5.5% of the sample with a higher frequency in females compared to males. The maxillary second molar was the most involved tooth with a total incidence of 0.68% of all molar teeth (Bronoosh *et al*. 2012).

The highest prevalence was reported in China, Senegal and Turkey. A prevalence of 48% was reported in a Senegalese population by Sarr *et al*. (2000) and 46.4% was reported in a Chinese population, with females representing 56% and males 36% of the cases (MacDonald-Jankowski and Li 1993). In Turkey, a prevalence of 22.8 % was reported with a 4.2% incidence of molar teeth (Topcuoglu *et al*. 2011). All three studies were conducted using panoramic radiographs.

Table1. Comparative studies of the literature.

Area of the study	Sample size Teeth No*	Taurodontism Prevalence Prevalence in all teeth*	Gender Dominance	Type of radiographs	Method used	Authors
Germany	800	2.25%	Females (insignificant)	Periapical radiographs	Shifman and Chanannel (modified)	Bürklein *et al.* (2011)
Trinidad	1,090	11.28% 4.79*%	Males (insignificant)	Periapical and panoramic radiographs	Visual Shaw	Pillai *et al.* (2007)
Jordan	875 2,636*	8% 4.4*%	Females (insignificant)	Periapical radiographs	Visual Shaw	Darwazeh *et al.* (1998)
Isreal	1200 10204*	5.6% 1,5*%	Females (insignificant)	Periapical and bitewing Radiographs	Shifman and Chanannel	Shifman and Chanannel (1978)
Senegal	150 1,027*	48% 18.8*%	Females (insignificant)	Panoramic radiographs	Shifman and Chanannel	Sarr *et al.* (2000)
China	196 1,093*	46.4% 21.7*%	Females (significant)	Panoramic radiographs	Shifman and Chanannel	MacDonald-Jankowski and Li (1993)
Saudi Arabia	1,581 1,647*	11.3% 43.2*%	Equal (insignificant)	Panoramic and periapical Radiographs	Shifman and Chanannel	Ruprecht *et al.* (1987)
India	1360 9792*	2.5% 1.21*%	Females (insignificant)	periapical radiographs	Shifman and Chanannel	Gupta and Saxena (2013)
Iran	510 7022*	5.5% 0.68*%	Females (significant)	panoramic radiograph	Visual & Blumberg index	Bronoosh *et al.* (2011)
Turkey	490 7684*	22.8% 4.2*%	Males (insignificant)	panoramic radiograph	Shifman and Chanannel	Topcuoglu *et al.* (2011)

2.4 Specific Location of Taurodontism

Taurodontism can occur in both permanent and deciduous dentitions (Terezhalmy *et al*. 2001; Neville *et al*. 2002; Bhat *et al*. 2004). The prevalence of taurodontism in the primary dentition was reported in a few studies: One study in India reported the prevalence of taurodontism occurring in mandibular primary first molars at 0.4% (Nagaveni and Radhika 2012). The other study of Turkish children revealed a 2.4% prevalence of taurodontism in all posterior primary teeth, where 2% was located in the primary first mandibular teeth (Huseyin *et al*. 2015).

Taurodontism can occur unilaterally or bilaterally, and presents in any combination of teeth or quadrants (White and Pharoah 2004). Although the most commonly affected teeth are permanent molars, some studies have reported the occurrence in premolar teeth (Llamas and Jimenez-Planas, 1993). The majority of authors did not include the premolars in their study because they believed that taurodontism could not occur in the premolars or single rooted teeth (Ruprecht *et al*. 1987). The few studies that included the premolars, reported a low prevalence of taurodontism in premolar teeth (Darwazeh *et al*. 1998; Llamas and Jimenez-Planas 1993; Patil *et al*. 2013).

The overall impression is that the second molars showed the most prevalence for taurodontism. Studies by MacDonald-Jankowski and Li (1993), Darwazeh *et al*. (1998), Gupta and Saxena (2013), and Topcuoglu *et al*. (2011) reported that the maxillary second molar had the highest reported number, while some studies reported the second mandibular molar to be the most affected tooth (Shifman and Chanannel 1978; Bronoosh *et al*. 2012; Andersson *et al*. 2013).

Patil *et al*. (2013) reported that the mandibular second molars were the most affected, while a similar study by Gupta and Saxena (2013) found the maxillary

second molar to be the most prevalent. When comparing the prevalence amongst the 3 different molars, it was observed that the most affected teeth were the second molars, followed by the first molars and lastly, the third molars. The third molars were however excluded from most studies (Andersson *et al*. 2013).

Table 2. Indicating the most affected tooth from various studies.

Area of the study	Most affected tooth	Authors
Trinidad	Mandibular first premolar	Pillai *et al*. (2007)
Jordan	Maxillary second molar	Darwazeh *et al*. (1998)
Isreal	Mandibular second molar	Shifman and Chanannel (1978)
China	Maxillary second molar	MacDonald-Jankowski and Li (1993)
India	Maxillary second molar	Gupta and Saxena (2013)
Iran	Mandibular second molar	Bronoosh *et al*. (2011)
Turkey	Maxillary second molar	Topcuoglu *et al*. (2011)

2.5 Conclusion

It is apparent that taurodontism shows varying prevalences in some populations, being as high as 48% in some parts and very rare in other parts of the world. These differences in prevalences may be attributed to the diversity in social structures and ethnic variations especially in growing populations as the world begins to transform into one large global village. The diverse mixing of different nationalities in most countries highlights the importance of establishing the prevalence and implications of taurodontism.

The large discrepancies in the prevalence could be attributed to the different criterion used for the interpretation of taurodontism (Jafarzadeh *et al*. 2008). It is

regarded by most that the diagnosis of taurodontism cannot be confirmed on dentitions that are still developing and which show open apices (Benazzi *et al*. 2014).

The literature provides variations in the prevalence of taurodontism between males and females; between maxillary and mandibular teeth; and between premolar and molar teeth. These variations can potentially impact on treatment and therefore highlights the importance of understanding the prevalence of taurodontism in a Western Cape context.

The purpose of this study is to assess the prevalence of Taurodontism in a South African context and more specifically in the Western Cape (patients that have attended the OHC at Tygerberg); assess the difference in prevalence between males and females; and assess the most affected teeth.

Chapter 3

AIM AND OBJECTIVES

Aim

Analysis of the occurrence of taurodont molars among patients attending the Tygerberg Oral Health Centre.

Objectives

- to determine the prevalence of taurodontism in molars.
- to determine the gender distribution of taurodontism.
- to determine the most prevalent type of taurodontism.
- to determine the distribution of taurodont molars (maxillary vs mandibular).
- to determine the location of taurodont molars (first, second, third molar).

Chapter 4

METHODOLOGY AND MATERIALS

4.1 Study Design

This study is a descriptive cross-sectional retrospective design.

4.2 Sample Size

A convenient sample of 1608 panoramic radiographs was selected from the archives of patients' records at the Tygerberg Oral Health Centre, Faculty of Dentistry, UWC during the period of January 2005 to December 2005. This one year period ensured a meaningful sample size was obtained.

4.3 Study Population

Inclusion Criteria

- Radiographs of patients above the age of 18 years.
- Only radiographs which were taken in Tygerberg Oral Health Centre hospital with full demographic details of the patients were used for this study.
- Good diagnostic quality radiography that shows at least 2 molars per quadrant with completed root formation.

Exclusion Criteria

- Patients under 18 years old were excluded.
- Panoramic radiographs not showing adequate diagnostic quality.
- Incomplete apical foramen formation teeth were not included.
- In addition, fractured molar teeth and undetectable furcation and fused molar roots were not included.

4.4 Data Collection

A sample of 1608 panoramic radiographs, having met the inclusion criteria, from a total of 7174 panoramic radiographs, were included in the study.

4.5 Data Processing and Analysis

Two experienced examiners from the oral and maxillofacial radiology department were used to obtain a gold standard. Three groups of 50 radiographs were examined by the two experienced examiners after they were familiarized with Shaw's classification of taurodontism and the modified classification of Shifman and Chanannel (1978). The lower second molar on the right side was used for the exercise. The same 150 radiographs were re-examined 2 weeks later by the senior examiners. Diagnosis was recorded once mutual consensus was agreed.

All the radiographs that met the inclusion criteria were divided into 32 groups of 50 panoramic radiographs each.

50 panoramic radiographs were examined at a time to minimize examiner fatigue.

All the panoramic radiographs were viewed on the same viewing box with fixed light intensity; ambient light was eliminated or kept to a minimum.

Radiographs were evaluated for presence of a large pulp chamber in relation to outer tooth configuration, less marked cervical constriction than the normal tooth form, an apically displaced furcation and short roots based on Shaw`s diagnostic method.

All radiographs that presented positive for taurodontism were converted to digital images by being scanned with a flat-bed scanner.

The posterior teeth that demonstrated large pulp chambers and less marked cervical constriction (than normal) and apically displaced furcation and short roots were further examined to measure the distance between the CEJ and the highest point of the floor of the pulp chamber with the aid of a software package called ImageJ® 1.46r (Microsoft®). The value obtained from measuring this distance was used to determine the degree of taurodontism for every tooth.

Hypotaurodontism will be defined as a range of 3.5-5.0mm, Mesotaurodontism 5.5-7.0mm and Hypertaurodontism 7.5mm or over, according to the modified classification of Shifman and Chanannel (1978); Tulensalo *et al*. (1989).

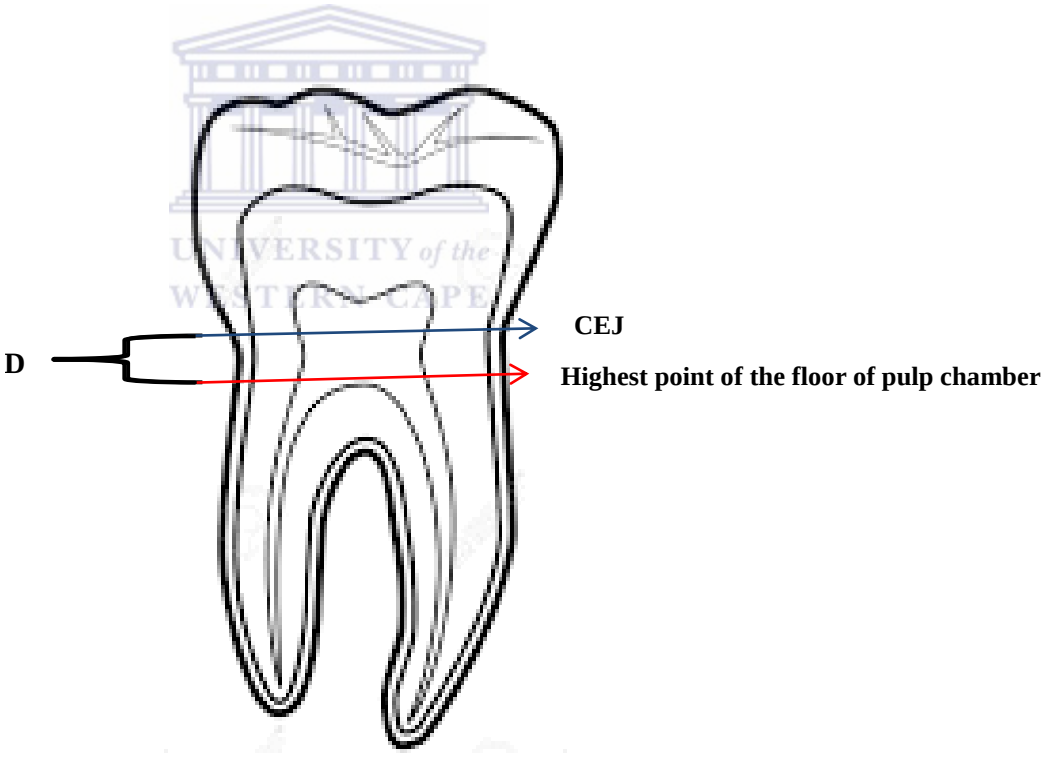


Figure 4: Diagram of measuring the distance between CEJ and highest point of the floor of the pulp chamber.

The diagnosis of taurodontism was confirmed by an alternate method called the

taurodontism Index which makes use of measuring two variables: (*Variable 1)* the vertical height of the pulp chamber - the distance between the lowest point of the roof of the pulp chamber and the highest point in the floor of the pulp chamber; *(Variable 2)* the distance between the lowest point of the roof of the pulp chamber and the apex of the longest root (Shifman and Chanannel 1978).

To calculate the TI (Taurodontism index) $= \frac{\text{variable1}}{\text{variable2}} \times 100$

Taurodontism was diagnosed in those molars in which the TI was above 20 and using these findings in terms of TI, degrees of T were determined to be: hypo-T 20-30; meso-T 30-40; and hyper- T 40-75.

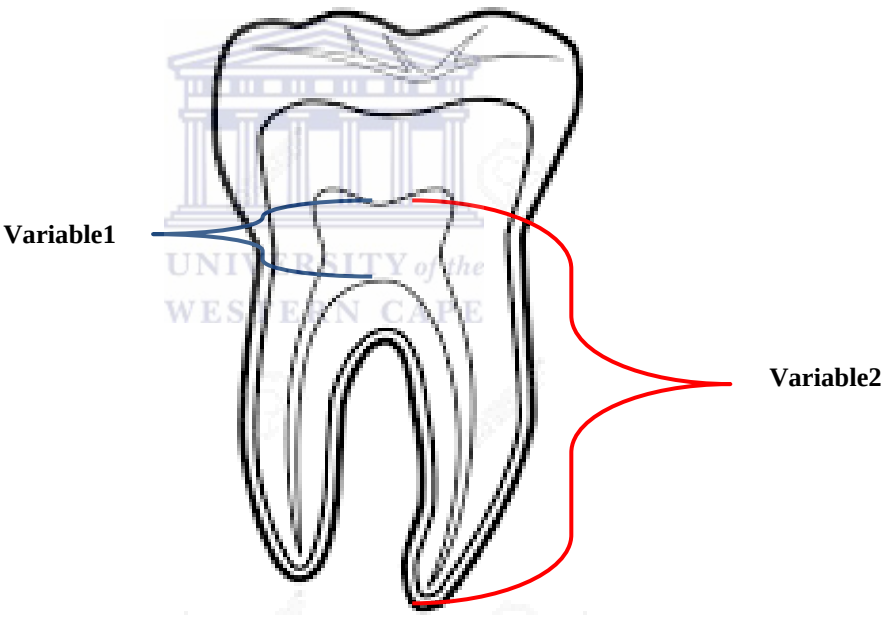


Figure 5: Diagram of measurement landmarks of TI.

All the data that was collected was entered into a Microsoft Excel 2011® spread sheet. Each panoramic radiograph was assigned a number to maintain anonymity. Statistical analysis of the data was performed using the computer program SPSS for Microsoft Windows7 and the frequency distribution for taurodontism was calculated. The Chi-square test was used to compare the prevalence of

taurodontism between male and female subjects, and the correlations regarding the location of taurodont teeth (maxillary versus mandibular).

4.6 Data Capturing

Positive findings were collected and captured as (yes) and the measurements were recorded using a Microsoft Excel 2011® spreadsheet (Refer to appendix 9.2).
The data spreadsheet was based on the objectives set out for this study.
The tooth number according to the Federation Dentaire International Numbering System (FDI), taurodontism type and its measurements for each molar tooth was recorded.

4.7 Ethical Consideration

The protocol was submitted to the Senate Research Ethics Committee of the University of Western Cape and was subsequently approved (14/10/67) and permission was granted to carry out the study (Refer to appendix 9.1).

Permission was obtained from the Dean of the Faculty of Dentistry to make use of patient records.
All patient information obtained during this study was deemed confidential and no personal information was divulged. Patient names were substituted by numbers.

Chapter 5

THE RESULTS

The study sample comprised 7174 panoramic records, of which 1608 fulfilled the inclusion criteria. 815 of these radiographs belonged to females (50.7%) and 793 panoramic radiographs (49.3%) belonged to males. From the 1608 panoramic radiographs, 52 (3.23%) radiographs showed positive for single or multiple taurodontism.

Distribution of taurodontism according to gender showed a female prevalence of 30/815 (3.68%), and male prevalence of 22/793 (2.77%). According to a chi-square test these two observed prevalences are not statistically significantly different: chi-square = 0.7861, df = 1, p-value = 0.3753.

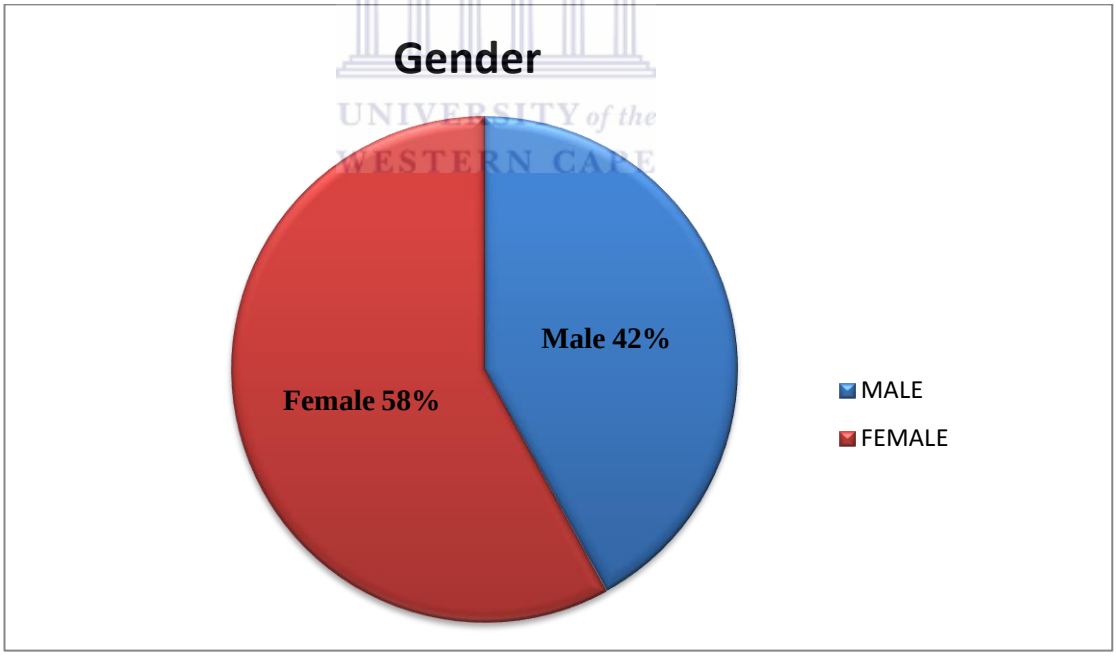


Figure 6. Pie graph indicating the percentage gender difference of taurodontism distribution.

According to this study the highest incidence of taurodontism was found in the mandible, thirty six patients from a total of 52 had mandibular taurodontism, while only one patient had maxillary taurodontism. The remainder (15 patients) presented with both maxillary and mandibular taurodontism.

Table 3. Distribution of taurodontism in the maxilla and mandible by gender.

Jaw	Male	Female	Total
Mandible	14	22	36
Maxilla	0	1	1
Maxilla & Mandible	8	7	15
Total	22	30	52

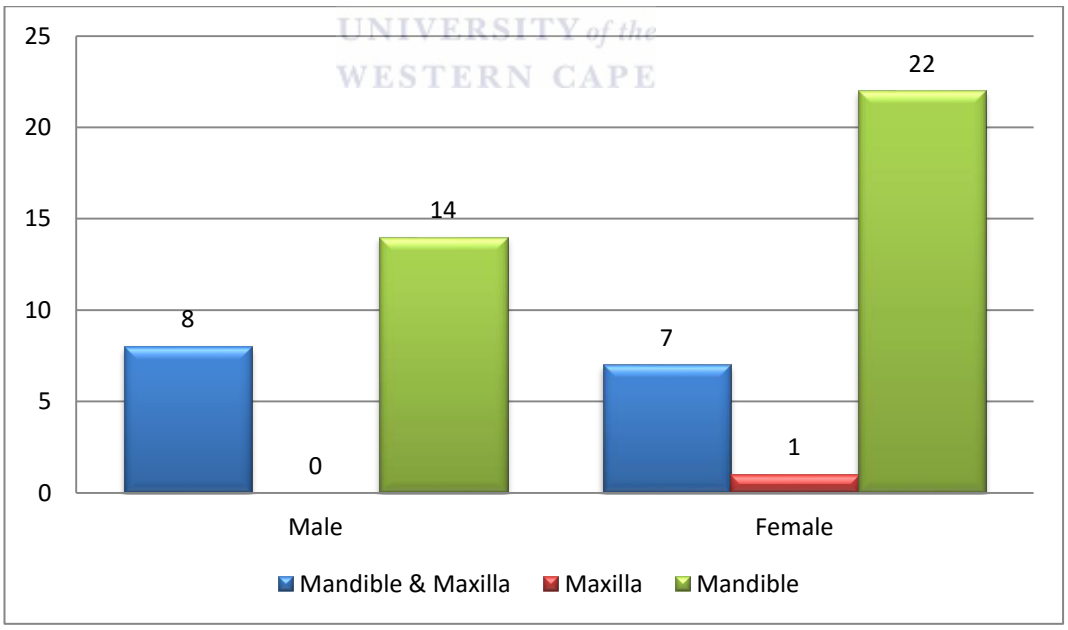


Figure 7. Graph indicating the distrbution of taurodontism in the maxilla and mandible by gender.

The total number of taurodont molars observed in the mandible equalled 103 (82.4%). This was distributed between 63 molars in females and 40 molars in males versus 22 taurodont molars in the maxilla (17.6%) comprising 10 molars in females and 12 molars in males.

Table 4. Distribution of taurodont teeth in the maxilla and mandible by gender.

Jaw	Male	Female	Total
Mandible	40	63	103
Maxilla	12	10	22
Total	52	73	125

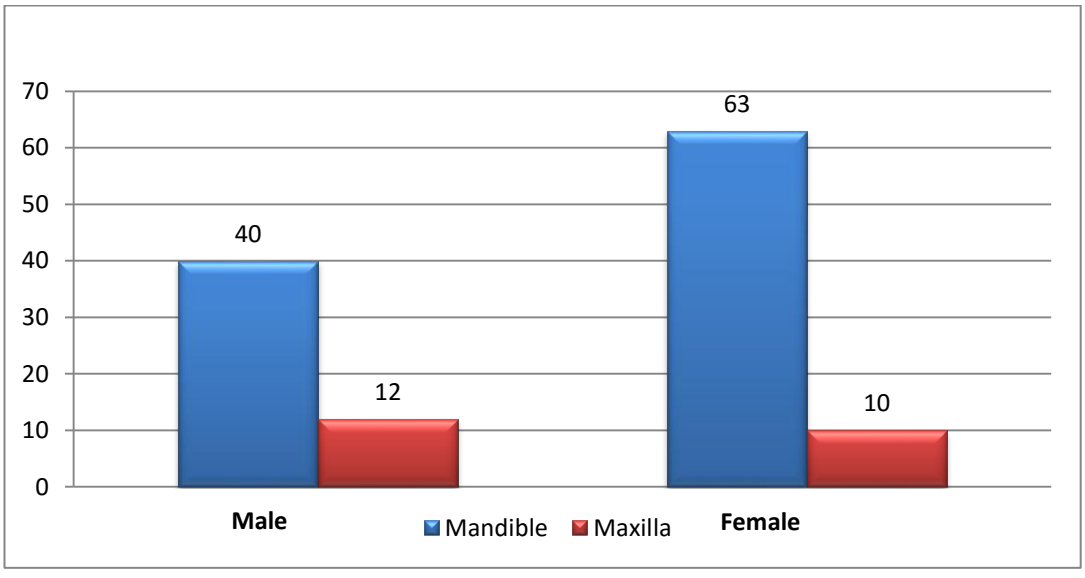


Figure 8. Distribution of taurodont teeth in the maxilla and mandible by gender.

Table 5. Summary of the combined results. It depicts the number of taurodontic teeth in the maxilla which was 22, and the mandible 103.

	Location	Sum
MAX	Upper teeth (maxillary teeth)	22
MAND	Lower teeth (mandibular teeth)	103
16	Right upper first molar tooth	1
17	Right upper second molar tooth	4
18	Right upper third molar tooth	3
26	Left upper first molar tooth	1
27	Left upper second molar tooth	8
28	Left upper third molar tooth	5
36	Left lower first molar tooth	0
37	Left lower second molar tooth	37
38	Left lower third molar tooth	12
46	Right lower first molar tooth	2
47	Right lower second molar tooth	31
48	Right lower third molar tooth	21

The total number of individual taurodont teeth was 125 (0.73%), from a total of 17148 molar teeth that were examined. This was categorized by the morphological classification into the following 3 classes: Hypertaurodontism 5 (4%), Mesotaurodontism 18 (14.4%) and Hypotaurodontism 102 (81.6%). The prevalence of hypotaurodontism in males and females was 90.4% vs 75.3%. However, the difference was not statistically significant (P=0.332).

Table 6. Distribution of types of taurodontism between males and females.

Morphology	Male	Female	Total
Hypo	47	55	102
Meso	4	14	18
Hyper	1	4	5
Total	52	73	125

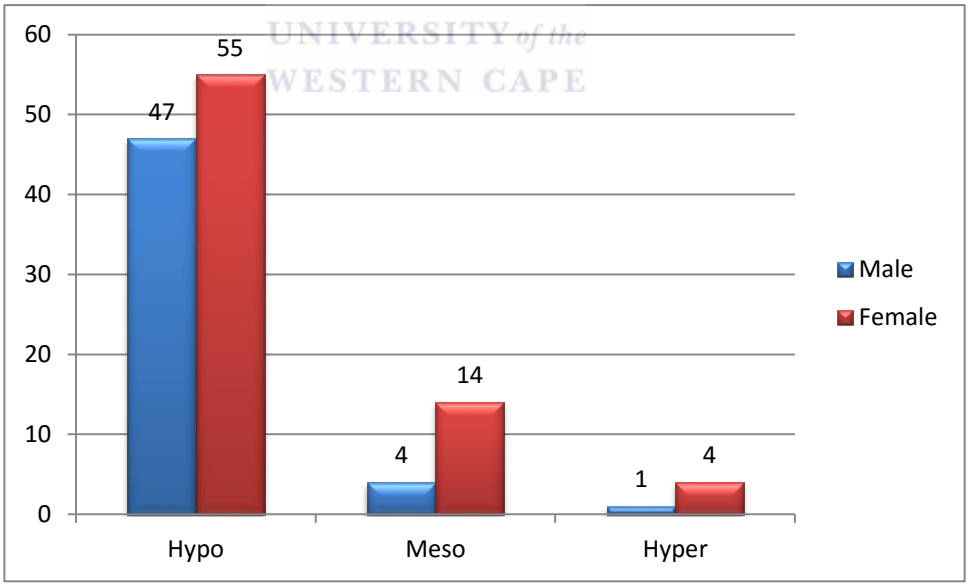


Figure 9. Distribution of types of taurodontism between males and females.

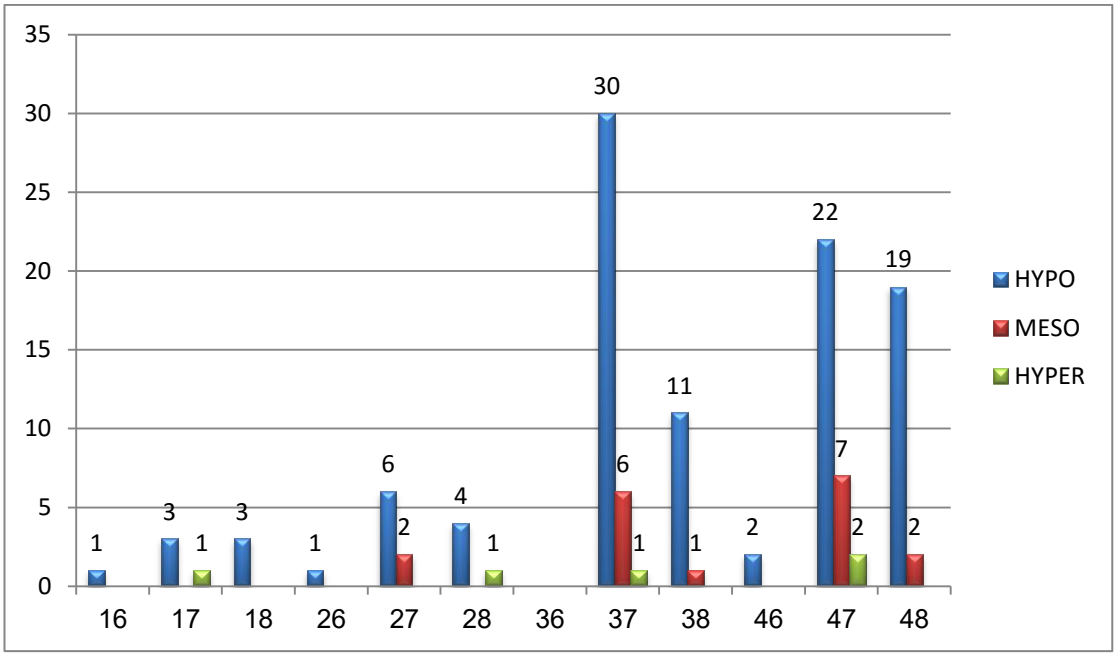


Figure 10. Graph indicating the distribution of taurodontism according to the morphology among upper & lower molar teeth.

Taurodont teeth were essentially more common in the mandible 103 (82.4%) than in the maxilla 22 (17.6%). The mandibular second molar 68 (54.4%) was the most affected tooth, followed by the lower third molar 33 (26.4%), then the upper second molar 12 (9.6%) and the upper and lower first molars were the least affected teeth with 2 (1.6%) each.

Table 7. Classification of taurodontism and distribution between 1st, 2nd and 3rd maxillary molars.

	Upper 1st molar	Upper 2nd molar	Upper 3rd molar	Total
Hypotaurodontism	2	9	7	18
Mesotaurodontism	0	2	0	2
Hypertaurodontism	0	1	1	2
Total	2	12	8	22

Table 8. Classification of taurodontism and distribution between 1st, 2nd and 3rd mandibular molars.

	Lower 1st molar	Lower 2nd molar	Lower 3rd molar	Total
Hypotaurodontism	2	52	30	84
Mesotaurodontism	0	13	3	16
Hypertaurodontism	0	3	0	3
Total	2	68	33	103

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Figure 11. Panoramic radiograph showing multiple taurodont molars.

Chapter 6

DISCUSSION

The prevalence of taurodontism in patients attending the Tygerberg Oral Health Centre was reported as 3.23% of all patients (N=1608) and 0.73% of all teeth examined had evidence of taurodontism.

These results were in accordance with previous studies in Europe and the Middle East, for example in Germany (2.25%) Bürklein *et al*. (2011), the South of Iran (5.5%) Bronoosh *et al*. (2012) and Israeli (5.6%) (Shifman and Chanannel 1978). Darwazeh *et al*. (1998) reported a slightly higher incidence in a Jordanian population (8%) while Ruprecht *et al*. (1987) reported (11.3%) in Saudi dental patients. In contrast to studies reported by MacDonald-Jankowski and Li (1993) of an adult Chinese population where 46.4% had a diagnosis of taurodontism. Similar high values were reported in a study of a Senegalese population (48%) as reported by Sarr *et al*. (2000). The distinguishing variable from these two high results is the small sample size used which accounted for less than two hundred patients. This is in comparison to most other studies encountered in the literature were sample sizes range between 800 and 1200.

A recent study conducted by Topcuoglu *et al.* 2011 using panoramic radiographs in Turkey reported that (22.8%) of the patients showed taurodontism. This result is considerably higher than our findings wherein both studies evaluated panoramic radiographs. The Turkish study made use of the Shifman and Chanannel method for the diagnosis which was established for periapical and bitewings radiographs. It is also a higher result because of the comparative sample size being 490 subjects, around half the mean of most studies mentioned.

The variance in the incidence from different parts of the world could be due to ethnic differences, sample size or differences in diagnostic principles. More

studies need to be done in Africa, Europe and Asia to be able to accurately compare previous studies across ethnic groups. These could then be correlated amongst the various continents to provide more meaningful results.

Another factor that could be the cause of varying prevalences was the teeth used in the diagnostic criteria of the study.
Some studies included the premolars in their assessment (Darwazeh *et al*. 1998; Topcuoglu *et al*. 2011; Pillai *et al*. 2007), while other authors did not include the premolars because they believed that taurodontism cannot affect premolar teeth. Most premolars (with the exclusion of the first maxillary premolar) are single rooted teeth and thus do not have anatomical or apically positioned features in the floor of the pulp chamber (Ruprecht *et al*. 1987; Bürklein *et al*. 2011; MacDonald-Jankowski and Li 1993). This study used permanent molars to diagnose taurodontism and did not include any premolars.

In this study a higher prevalence of Taurodontism was observed in the female sample (3.68%), in comparison to the prevalence in the male sample (2.77%), with no statistically significant difference (P value > 0.05). There was also a higher distribution of taurodont teeth in the mandibles of female patients (63) compared to the mandible of male patients (40). Few studies reported statistical differences across gender. It was reported in a Chinese population by MacDonald-Jankowski and Li (1993) (56% females: 36% males, $P < 0.01$); in studies conducted in South Iran (P>0.05) and India (Bronoosh *et al*. 2012; Gupta and Saxena 2013). The results of gender prevalence from the present study were similar to the studies done by Ruprecht *et al*. 1987; Shifman and Chanannel 1978; Darwazeh *et al*. 1998.

A genetic study conducted by Varrela and Alvesalo (1988) showed that patients with an extra X chromosome, number 47, as in XXY males with Klinefelter's Syndrome had a higher incidence of taurodontism. Komatz *et al*. (1978) suggested that the X chromosome contains gene(s) that favoured the development of

taurodontism which implied that taurodontism should be more prevalent in females, as was found in a Chinese population.

According to results of the present study the mandibular molar teeth (103/125) are more affected than the maxillary molar teeth (22/125). The second mandibular molars were the most affected (54.4%) followed by mandibular third molars (26.4%) and the maxillary second molars were the least affected (9.6%). These results are consistent with studies done by Andersson *et al*. (2013) who reported that the second mandibular molars had the highest prevalence of taurodontism, 72.3%. Coincidentally, the sample consisted of individuals diagnosed with Laurence-Moon/Bardet-Biedl syndrome. Another study with a similar high prevalence of taurodontism of second mandibular molars (53.2%) was recorded by Patil *et al*. (2013). Shifman and Chanannel (1978) found that the second mandibular molar was the most prone tooth, being involved in two thirds of all cases found.

In comparison to other studies, the study done by Gupta and Saxena (2013) reported taurodontism to be more frequent in the maxillary second molars (35/118) with small differences with mandibular second molar observed (32/118). Darwazeh *et al*. (1998) also found that the most common effected tooth was the second maxillary molar which forms about 31% of all taurodontic teeth.

Second molars are the most affected teeth in all the studies. This may be attributed to genetic effect during their development. The significance of a high prevalence of taurodontism in second molars has not been documented in previous literature. The genetic implication could justify a gender predilection but not a specific tooth. One would expect that a genetic coding that affects the morphology of teeth would affect all the teeth (molars) and not just one. It is perhaps due to an event or alteration that occurs in a development stage of a person. Presumably the pulp could be measured once the crown and more than a third of the root is developed in order to measure the height of the pulp. This could be done in the age range of 11 to 13 years to ascertain if any damage was encountered during development.

The literature commonly hints to a possibility of a technical error of distortion being responsible for some diagnosis of taurodontism. This is due to the possible angulation of the second molar and the positioning and angulation of posterior teeth on radiographs that give the appearance of taurodontism. A physical measurement of the pulp or a more accurate imaging technique may be the solution to overrule the theory of distortion. Cone beam computed tomography may be a viable method to conduct further studies regarding taurodontism as the image has a one to one ratio and is more accurate.

In the present study hypotaurodontic molars (81.6%) were more common than mesotaurodonts (14.4%) and hypertaurodonts (4%), with no significant differences found in the type of taurodontism between males and females ($p>0.05$). This was similar to the results of other studies which reported the difference between the types of taurodontism. Patil *et al*. (2013) reported a prevalence of 75% for hypotaurodontism, 18.8% for mesotaurodontism and hypertaurodontism 6.2%. This trend was also reported by Bronoosh *et al*. (2012) who reported hypotaurodontism as 67%, mesotaurodontism 31% and hypertaurodontism 2%. This study was comparatively similar in that diagnosis ranged in familiar patterns where hypotaurodontism was the highest around 60 to 80%, mesotaurodontism was intermittent between 20 to 30% and hypertaurodontism was less than 10%.

Chapter 7

CONCLUSION

From this study it can be concluded that the prevalence of taurodontism in patients attending the Tygerberg Oral Health Centre was 3.23%, with females having a higher prevalence rate than males. The mandibular molar teeth were more affected than the maxillary molar teeth, especially the second mandibular molar teeth which had the highest rate of taurodontism (54.4%). This incidence is low (3.23%), but still has clinical significance for general dental clinicians. The association with genetic syndromes will always be an important consideration for appropriate management.

Racial expression of different populations plays an important role in the variation of prevalence of taurodontism, but may also be influenced by other factors such as sample size, differences in diagnostic principles and also the specific teeth being examined.

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9. APPENDICES

Appendix 9.1

Office of the Deputy Dean
Postgraduate Studies and Research
Faculty of Dentistry & WHO Collaborating Centre for Oral Health

UNIVERSITY OF THE WESTERN CAPE
Private Bag X1, Tygerberg 7505
Cape Town
SOUTH AFRICA

Date: 5th December 2014

For Attention: Dr M Benzahya
Faculty of Dentistry
Tygerberg Campus

Dear Dr Benzahya

STUDY PROJECT: Analysis of the occurrence of tuarodontism in patients attending the Tygerberg Oral Health Centre

PROJECT REGISTRATION NUMBER: 14/10/67

ETHICS: Approved

At a meeting of the Senate Research Committee held on Friday 5th December 2014 the above-mentioned project was approved. This project is therefore now registered and you can proceed with the study. Please quote the above-mentioned project title and registration number in all further correspondence. Please carefully read the Standards and Guidance for Researchers below before carrying out your study.

Patients participating in a research project at the Tygerberg and Mitchells Plain Oral Health Centres will not be treated free of charge as the Provincial Administration of the Western Cape does not support research financially.

Due to the heavy workload auxiliary staff of the Oral Health Centres cannot offer assistance with research projects.

Yours sincerely

Professor Sudeshni Naidoo

Tel -27-21-937 3148 (w); Fax -27-21-931 2287 e-mail: suenaidoo@uwc.ac.za

Appendix 9.2. Example of data collection spreadsheet

File No	Allocated No	Age	Sex	Max	Mand	16	D	TI	17	D	TI	18	D	TI	26	D	TI	27	D	TI	28	D	TI
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File No	Allocated No	Age	Sex	Max	Mand	36	D	TI	37	D	TI	38	D	TI	46	D	TI	47	D	TI	48	D	TI
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	2																						
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