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Evaluating First Molar Enamel and Dentin Thickness Measurements Using Cone Beam Computed Tomography (CBCT) in Dental Imaging: A Retrospective Study

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Abstract

Background: In the evolving landscape of dentistry, a comprehensive retrospective CBCT analysis of enamel and dentin thickness in the first molar provides essential insights into demographic correlations, refining treatment precision, and addressing the multifaceted nature of dental anatomy. Aim: To explore potential correlations between enamel and dentin thickness and demographic factors. Methodology: The current retrospective study at Qassim University analysed CBCT scans of 400 participants aged 18-40, focusing on first molar teeth. Data, including enamel and dentin thickness, were systematically extracted and analysed using SPSS version 21.0, applying descriptive statistics, Chi-square and ANOVA tests for demographic relationships. Ethical standards were maintained, ensuring reliable measurements and statistical robustness. Results: The study findings revealed a balanced gender distribution (56% females), with the majority in the 26-35 age group. Tooth number 26 exhibited the highest frequency (33%). Enamel thickness varied across tooth numbers, and significant gender and age-related differences were observed, emphasizing the dynamic nature of dental anatomy. Conclusion: The study findings underscore the need for gender-tailored treatment considerations, highlighting significant variations in enamel and dentin thickness across different age groups.

Keywords: CBCT Analysis, Enamel Thickness, Dentin Thickness, Dental Anatomy.

Introduction

In the realm of specialised healthcare, dentistry is perpetually in search of innovations to refine the accuracy and effectiveness of treatment techniques. An essential element in this endeavour lies in the precise measurement of enamel and dentin thickness.1 These measurements are of paramount importance in a range of dental procedures, including restorations, crown installations, and orthodontic treatments. The precise evaluation of enamel and dentin thickness assumes a central role in treatment planning, equipping clinicians with the information needed to make informed decisions regarding the most appropriate interventions for each patient.2 Cone Beam Computed Tomography (CBCT) has emerged as a powerful tool in dental imaging, revolutionising the way dental professionals visualise and assess dental structures.3 Unlike conventional two-dimensional radiography, CBCT provides three-dimensional images with high spatial resolution, allowing for precise measurements of enamel and dentin thickness. This technology offers a non-invasive and radiation-efficient means of assessing dental anatomy and pathology. Its ability to provide detailed cross-sectional images and volumetric data has made CBCT indispensable in the field of dentistry for accurate diagnosis, treatment planning, and research.4

Recent studies utilising CBCT have yielded intriguing findings regarding enamel and dentin thickness.5,6 These investigations have highlighted the inherent variability in enamel and dentin thickness among individuals, emphasising the importance of patient-specific assessments. Additionally, CBCT has unveiled the relationship between enamel and dentin thickness and factors like age, gender, and tooth location, shedding light on the multifaceted nature of dental anatomy. These findings have stimulated discussions on how these variations may impact clinical decision-making, especially in restorative and endodontic procedures.

The primary objective of this study is to conduct a comprehensive retrospective CBCT analysis of enamel and dentin thickness in the first molar. By leveraging the capabilities of CBCT technology, the study aims to provide a detailed characterisation of the variations in enamel and dentin thickness in this pivotal tooth. Furthermore, the study intends to explore potential correlations between enamel and dentin thickness and demographic factors. The study seeks to enhance our understanding of the nuances of enamel and dentin anatomy, facilitating improved clinical decision-making and treatment outcomes in contemporary dental practice.

Methodology

This retrospective descriptive study was conducted at the Department of Diagnostics, College of Dentistry, Qassim University, during the period between June 2023 and November 2023, following approval “24-71-04” from the Ethics Committee of Qassim University. The study population consisted of patient records, aged between 18 to 40 years, retrieved from the dental clinics of Qassim University. These patients had undergone Cone Beam Computed Tomography (CBCT) scans for various dental procedures during the specified time frame.

To determine the required sample size, a formula was applied, considering a 95% confidence level (CI), a 5% margin of error (E), and an estimated proportion (P) of 50%. This calculation yielded a sample size of 400 participants. Inclusion criteria encompassed adults aged between 18 to 40 years, patients with accessible CBCT scans of the first molar teeth, those with complete and clear CBCT scans providing visibility of the first molars, and individuals with accompanying clinical records relevant to dental conditions and treatment history. Exclusion criteria included patients below 18 years of age, incomplete or poor-quality CBCT scans, individuals with a history of dental procedures on the first molars that may alter natural tooth anatomy, pregnant individuals, those with systemic diseases impacting dental health, patients with craniofacial anomalies or syndromes affecting tooth anatomy, individuals unable or unwilling to provide informed consent for the use of their CBCT data in

the study, those explicitly declining the use of their dental data for research, and CBCT scans of teeth other than the first molars.

Data collection involved a systematic approach to extract relevant information from CBCT scans of the first molar teeth. The CBCT scans utilised were obtained from the Department of Diagnostics, College of Dentistry, Qassim University. No CBCT images were taken specifically for this research purpose. Data recorded included demographic information, enamel and dentin thickness measurements, and clinical details, and it was meticulously organized in Microsoft Excel for systematic analysis. Informed consent was not applicable due to the retrospective nature of the study. Patient confidentiality was strictly maintained, and data were used solely for research purposes.

Data analysis was performed using SPSS version 21. Descriptive statistics were employed to summarize data, including enamel and dentin thickness measurements. The Chi-square test and ANOVA test were utilised to explore relationships between enamel and dentin thickness and various demographic and clinical factors. This systematic data collection method ensured adherence to ethical standards, accuracy in measurements, and the potential for robust statistical analysis. The findings from this comprehensive approach are anticipated to significantly contribute to the understanding of enamel and dentin thickness variations and their implications in dental treatment planning.

Results

Table 1 provides a comprehensive overview of the distribution of gender, age groups, and tooth numbers among the study participants. The gender distribution shows a slight preponderance of females, constituting 56% of the sample, compared to males at 44%. In terms of age categories, the majority of participants fall within the 26-35 age group (44%), followed by the 18-25 age group (36%) and those above 35 years (20%). The distribution of tooth numbers reveals variations, with tooth number 26 having the highest frequency at 33%, followed by tooth numbers 16, 36, and 46 at 26%, 22%, and 19%, respectively.

Table 1: Distribution of Gender, Age Group, and Tooth Number

		Frequency (n)	Percentage (%)
Gender	**Female**	224	56
	Male	176	44
Age Category	**18-25**	144	36
	26-35	176	44
	>35	80	20
Tooth Number	**16**	104	26
	26	132	33
	36	88	22
	46	76	19

Table 2 presents the mean and standard deviation of enamel thickness, dentin thickness, and maximum cervical crown width concerning different tooth numbers. For tooth number 16, the mean enamel thickness is 1.71 mm with a standard deviation of 0.28 mm, while the mean dentin thickness is 3.34 mm with a standard deviation of 0.36 mm. The maximum cervical crown width for tooth number 16 has a mean of 8.74 mm with a standard deviation of 0.69 mm. Similar patterns are observed for tooth numbers 26, 36, and 46, with variations in mean and standard deviation values.

Table 2: Mean and Standard Deviation of Enamel Thickness, Dentin Thickness, and Maximum Cervical Crown Width concerning Tooth Number

Tooth Number	Enamel Thickness Mean (mm)	Enamel Thickness SD (mm)	Dentin Thickness Mean (mm)	Dentin Thickness SD(mm)	Maximum Cervical Crown Width Mean (mm)	Maximum Cervical Crown Width SD (mm)
16	1.71	0.28	3.34	0.36	8.74	0.69
26	1.64	0.30	3.28	0.50	8.42	0.71
36	1.64	0.26	3.25	0.35	9.21	0.62
46	1.74	0.31	3.31	0.32	8.83	0.59

Table 3 presents a comparison of mean measurements of enamel thickness, dentin thickness, and maximum cervical crown width based on gender. For enamel thickness, females exhibit a mean of 1.70 mm, significantly different from males with a mean of 1.65 mm (p-value < 0.05). Similarly, dentin thickness in females (mean = 3.31 mm) significantly differs from males (mean = 3.28 mm) with a p-value < 0.05. However, there is no significant difference in the maximum cervical crown width between females (mean = 8.73 mm) and males (mean = 8.79 mm), as indicated by the p-value > 0.05. Table 4 compares mean measurements of enamel thickness, dentin thickness, and maximum cervical crown width across different age groups. Notably, significant differences are observed in enamel thickness between the age categories (p-value < 0.05). Specifically, the 18-25 age group has a mean enamel thickness of 1.77 mm, which differs significantly from the 26-35 age group (mean = 1.59 mm) and the >35 age group (mean = 1.70 mm). However, no significant differences are found in dentin thickness among the age groups (p-value > 0.05). For maximum cervical crown width, significant differences are observed between the 18-25 age group (mean = 8.60 mm) and the other two age groups (26-35 and >35), emphasizing age-related variations in dental anatomy. Figure 1 and 2 illustrates cervical crown width, enamel and dentin thickness for the maxillary and mandibular molar teeth respectively.

Table 3: Comparison of Mean Measurements by Gender

Gender	Enamel Thickness Mean (mm)	P value (<0.05*)	Dentin Thickness Mean (mm)	P value (<0.05*)	Maximum Cervical Crown Width Mean (mm)	P value (<0.05*)
Female	1.70	0.00*	3.31	0.00*	8.73	0.20*
Male	1.65		3.28		8.79	

Table 4: Comparison of Mean Measurements by Age groups

Age Category	Enamel Thickness Mean (mm)	P value (<0.05*)	Dentin Thickness Mean (mm)	P value (<0.05*)	Maximum Cervical Crown Width Mean (mm)	P value (<0.05*)
18-25	1.77	0.00*	3.31	0.79	8.60	0.00*
26-35	1.59		3.29		8.84	
>35	1.70		3.28		8.86	

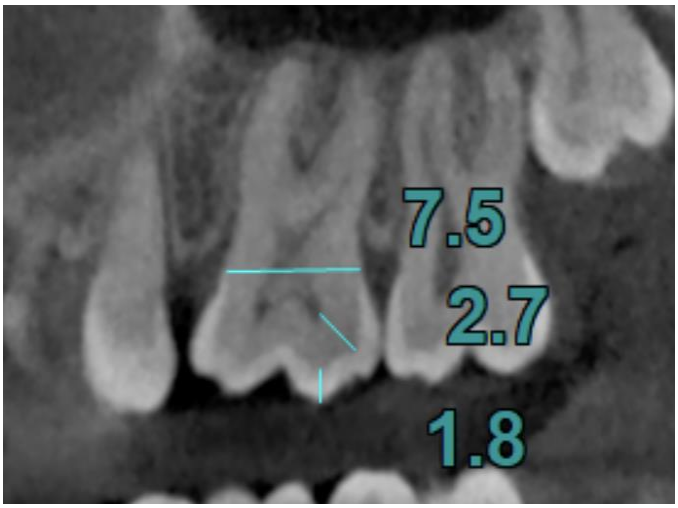

Figure 1: Cervical Crown Width, Enamel and Dentin Thickness for Maxillary Molar Tooth

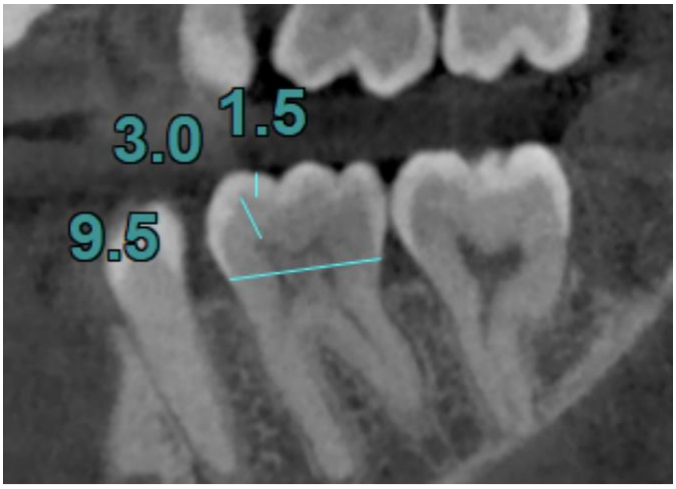

Figure 2: Cervical Crown Width, Enamel and Dentin Thickness for Mandibular Molar Tooth

Discussion

The findings of this comprehensive retrospective CBCT analysis align with and contribute to a growing body of literature exploring enamel and dentin thickness variations using advanced imaging techniques. Several studies in the field have also delved into the multifaceted nature of dental anatomy, emphasising the impact of demographic factors on enamel and dentin measurements.7,8 A study by Daubert et al., utilised CBCT to investigate enamel thickness variations in a diverse population.9 Similar to the current study findings, the authors have reported significant differences in enamel thickness between gender groups. The study, however, also delved into ethnicity as a potential influencing factor, revealing noteworthy variations among different ethnic backgrounds. The incorporation of ethnic considerations in future studies could provide a more comprehensive understanding of dental anatomy.

In another investigation, Zilberman et al., explored age-related variations in dentin thickness using CBCT technology.10 The findings corroborate the present study's findings of age-specific differences in enamel thickness, supporting the notion that age plays a crucial role in shaping dental anatomy. By considering both enamel and dentin thickness in tandem, a more holistic understanding of age-related changes in dental structures can be achieved. Furthermore, the study by Towle et al., scrutinized the impact of tooth location on enamel and dentin thickness, extending beyond the first molar.11 The research highlighted that variations in dental anatomy are not only confined to specific teeth but also influenced by their position within the oral cavity. Incorporating insights from such studies into the present analysis can contribute to a more comprehensive characterisation of enamel and dentin thickness variations across various teeth.

The observed gender-specific differences in enamel and dentin thickness have also been explored in studies by Stroud et al.12 The research not only affirmed gender-related variations but also proposed a link between hormonal factors and dental anatomy. Integrating hormonal influences into future investigations could unveil additional layers of complexity in the relationship between gender and dental structures. This retrospective CBCT analysis offers valuable insights into enamel and dentin thickness, but limitations include a lack of exploration into systemic factors impacting dental anatomy. The study's focus on the first molar, while informative, suggests the potential for a more comprehensive understanding by analysing a broader range of teeth. Longitudinal data exploration and consideration of dynamic factors could enhance insights into age-related variations. Further research on the influence of oral hygiene practices, dietary habits, and socio-economic factors would contribute to a holistic perspective on dental health. Addressing these limitations and pursuing future research avenues is crucial for refining treatment approaches and promoting personalised dental care in specialised healthcare

Conclusion

The study findings revealed a balanced gender distribution, with females comprising 56% of the sample. Participants predominantly fell within the 26-35 age group (44%), and tooth number 26 exhibited the highest frequency (33%). The mean

enamel thickness varied across tooth numbers, with tooth 16 showing 1.71 mm, 26 with 1.64 mm, 36 with 1.64 mm, and 46 with 1.74 mm. Gender-specific comparisons unveiled significant differences in enamel and dentin thickness, emphasizing the need for gender-tailored treatment considerations. Age-related variations were evident, particularly in enamel thickness, highlighting the dynamic nature of dental anatomy across different age groups.

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