ORIGINAL RESEARCH

Evaluating the Thickness of the Root Canal Dentin Wall in Primary First Molars Using Cone-beam Computed Tomography

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Abstract

Aim: To evaluate the thickness of the root canal dentin wall in the cervical, middle, and apical third of primary first molars.

Materials and methods: Cross-sectional study consisting of 30 cone-beam computed tomography (CBCT) images of primary maxillary and mandibular first molars, with crown, and root integrity. The wall dentin thickness of each canal was measured in three axial views, divided into distal (D), mesial, lingual/palatine, and buccal surfaces.

Results: The smallest dentin wall thickness of the maxillary molar was located on the mesial surface of the mesiobuccal (MB) canal apical third (mean 0.55 ± 0.04 mm). The buccal and palatal (P) surfaces of the distobuccal (DB) and P canals showed the smallest dentin thickness on the cervical third (0.62 ± 0.02 mm). On the mandibular molar, we found the smallest dentin thickness on the apical third [lingual surface of the MB canal and buccal surface of the mesiolingual (ML) canal] with a mean of 0.41 ± 0.07 mm. Additionally, the dentin thickness is average of the D canal was about 0.67 ± 0.11 mm.

Conclusion: It is essential to understand the primary first molar's anatomy to reduce possible complications in pediatric patients from instrumentation during root canal treatments.

Clinical significance: Pulpectomy is among the most challenging procedures in pediatric dentistry and the knowledge of the root anatomy of primary teeth allows the professional to make better clinical decisions and reduce possible risks during root canal treatment.

Keywords: Cone-beam computed tomography, Dentin, Endodontics, Molar, Primary tooth.

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Introduction

Pediatric dentistry is a dental branch responsible for averting and treating orofacial conditions in children.[1,2] The scope of their responsibilities includes the preservation of primary teeth until their physiological exfoliation as they play an important role in the oral cavity conformation. However, one of the most common reasons for anticipated exfoliation is dental caries, which may compromise pulp vitality at more advanced stages.[3–8] In that regard, complex treatments (i.e., pulpectomy) may be necessary to preserve the tooth's structure, although it may affect the child's quality of life.[9] The primary and permanent dental anatomy differ in a range of characteristics. Such as in size and thickness of the dentin wall of the root and root canal, which is usually more curved and thinner. In addition, the permanent molar tooth germ is located between the roots of a primary molar (the interradicular space), which is considered a high-risk area due to the fragility and the smaller diameter of the dentin thickness.[10–15]

Previous research on primary root anatomy has employed cone-beam computed tomography (CBCT) because it is a high-technological tool that allows visualization of the internal characteristics of the molars and anatomical variations in comparison with the permanent dentition.[16–20] In addition, this technique is reproducible, noninvasive, and allows visualization of the primary first molar in three dimensions (axial, coronal and sagittal). Thus, it is one of the most widely used techniques for root canal assessment due to the high resolution and precision it provides.[3,10,16,19–29] Moreover, Acar et al.[20] and Ahmed et al.[29] found anatomical root canal variations of primary molars and their importance for clinical procedures.

However, there is a lack of evidence on the anatomy of root canals in primary teeth, specifically dentin thickness of the root canal thickness measurements, which could cause the pediatric dentist to experience complications in instrumentation during pulpectomy, preventing clinical success. Therefore, this study aimed to evaluate the dentin thickness of primary first molars at the root canal wall level with CBCT.

Materials and Methods

The study design was cross-sectional. A sample size formula for a single mean was utilized with a 95% confidence level and 80%

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power with the statistical software Epidat version 4.2 and using a pilot study's means. As such, 30 tomography images were evaluated in two equally distributed groups. These were extracted from a database owned by a private radiological practice. The evaluation of the CBCT images was performed using a tomograph (CBCT Planmeca ProMax 3D Mid). This research study was exempted by the Ethics Board of the Peruvian University of Applied Sciences in Lima, Peru (CEI 383 - 11 - 19-PI237 - 19).

We included tomographic images of primary first molars with a minimum root length of 7.9 mm since a smaller measurement represented signs of root resorption.[12] Consequently, we excluded those with external or internal resorption, with previous restorations or pulp treatment.

Training and calibration for tomographic analysis in the Planmeca Romexis Viewer® software (Planmeca, Finland) were carried out by the specialist in oral radiology. The degree of intraexaminer and interexaminer agreement was determined quantitively by κ statistical analysis, obtaining 0.82 (very good), and 0.63 (good), respectively.[21]

We measured the dentin thickness of the root canal walls by considering the root length of each canal in a sagittal view,[12] subsequently dividing it into thirds. Hence, we measured 3 mm in the cervical third (most concave cervical line or amelocemental junction), 2 mm in the middle third (from the first line), and 3 mm in the apical third (from the second line toward the apical) as suggested by Montoya et al.[13] The exact point of measurement was established in the center of each third (1.5 mm in the cervical third, 1 mm in the middle third, and 1.5 mm in the apical third). In this way, we sought to standardize the points measured in all the canals (Fig. 1).

We identified canals in the maxillary molar as distobuccal (DB), mesiobuccal (MB), and palatal (P). In the mandibular molar, these were MB, mesiolingual (ML), and distal (D). We then divided each molar canal into three sections (cervical, middle, and apical third) from the amelocemental line to the root tip in the axial view of the tomography. Each third was divided into four surfaces (D, mesial, buccal, and P/lingual), and the dentin thickness was measured in millimeters (Fig. 2). In addition, in the MB and ML canals of the primary mandibular first molars, dentin junction was evidenced at the level of the thirds, between the lingual surface of the MB canal and the buccal surface of the ML canal in which it was decided to

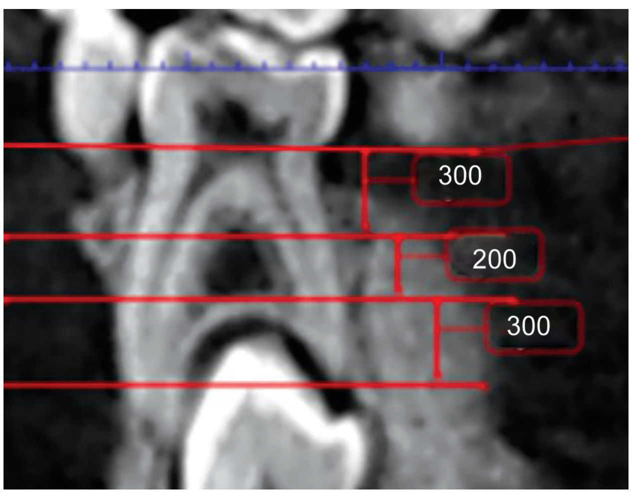

Fig. 1: Sagittal view of a primary mandibular first molar

make a single measurement. Therefore, each had a dentin thickness corresponding only to the surface and the third (Fig. 3).

Statistical analysis was performed using Stata version 15 (Stata Corporation, College Station, Texas, United States of America). The average dentin thickness measurement was expressed in millimeters.

Results

Tables 1 to 3 show the measurement of dentin thickness in millimeters of the primary maxillary first molars canals (MB, DB, and P), thirds, and surfaces (mesial, D, and P buccal). We found that in

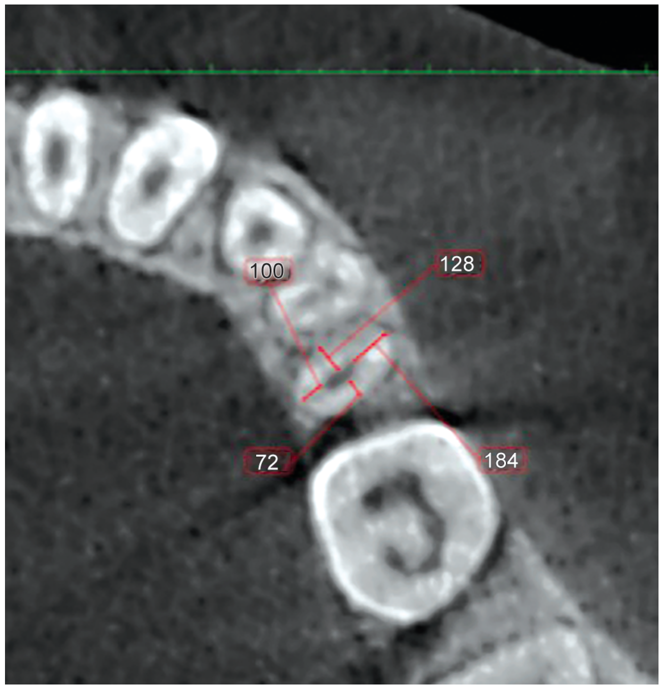

Fig. 2: Axial view at the level of the middle third of a primary mandibular first molar

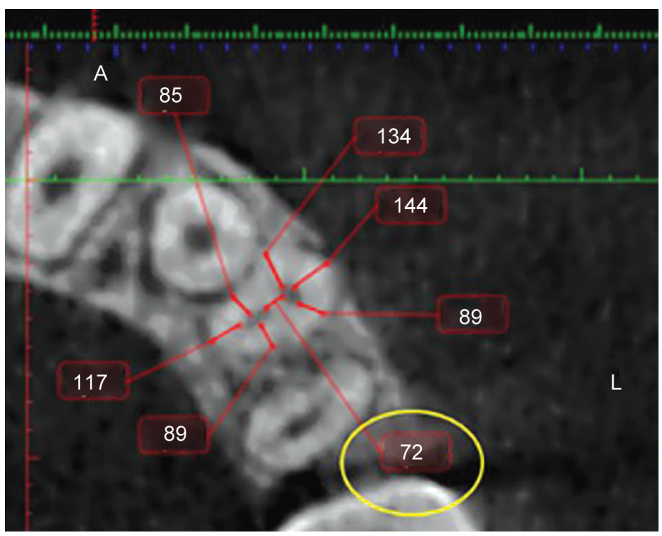

Fig. 3: Axial view, measurements of the mesial canal (buccal-lingual) of the primary mandibular first molar

Table 1: Measurement of dentin thickness in millimeters of primary maxillary first molar in MB canal, thirds, and surfaces (n = 15)

Canal	*Third*	*Surface*	*Mean*	*Standard deviation*	*50th percentile*	*Interquartile range*
MB	Cervical	Mesial	0.83	0.04	0.83	0.80–0.87
		D	0.62	0.03	0.62	0.60–0.64
		P	1.48	0.04	1.49	1.46–1.51
		Buccal	1.41	0.06	1.34	1.31–1.40
	Middle	Mesial	0.81	0.05	0.81	0.78–0.84
		D	0.72	0.07	0.7	0.66–0.78
		P	1.04	0.11	1.01	0.98–1.10
		Buccal	1.01	0.09	0.99	0.95–1.10
	Apical	Mesial	0.55	0.04	0.56	0.52–0.59
		D	0.63	0.03	0.62	0.61–0.65
		P	0.98	0.07	0.97	0.92–1.02
		Buccal	0.93	0.09	0.94	0.87–1.00

Table 2: Measurement of dentin thickness in millimeters of primary maxillary first molar in DB canal, thirds, and surfaces (n = 15)

Canal	*Third*	*Surface*	*Mean*	*Standard deviation*	*50th percentile*	*Interquartile range*
DB	Cervical	Mesial	0.83	0.06	0.84	0.79–0.88
		D	0.98	0.12	0.95	0.9–1.00
		P	0.62	0.02	0.62	0.6–0.63
		Buccal	1.79	0.02	1.79	1.78–1.80
	Middle	Mesial	0.78	0.03	0.78	0.76–0.81
		D	0.85	0.04	0.85	0.82–0.89
		P	0.69	0.07	0.68	0.65–0.74
		Buccal	1.27	0.04	1.28	1.22–1.30
	Apical	Mesial	0.64	0.04	0.62	0.61–0.65
		D	0.64	0.03	0.64	0.61–0.67
		P	0.66	0.05	0.67	0.62–0.70
		Buccal	0.95	0.05	0.95	0.90–1.00

Table 3: Measurement of dentin thickness in millimeters of primary maxillary first molar in P canal, thirds, and surfaces (n = 15)

Canal	*Third*	*Surface*	*Mean*	*Standard deviation*	*50th percentile*	*Interquartile range*
P	Cervical	Mesial	1.41	0.06	1.39	1.36–1.46
		D	1.15	0.07	1.17	1.08–1.20
		P	1.71	0.08	1.69	1.62–1.77
		Buccal	0.62	0.02	0.61	0.6–0.63
	Middle	Mesial	0.96	0.05	0.97	0.92–1.00
		D	0.92	0.05	0.91	0.88–0.94
		P	1.31	0.08	1.32	1.25–1.37
		Buccal	0.72	0.07	0.68	0.65–0.74
	Apical	Mesial	0.81	0.02	0.81	0.79–0.82
		D	0.71	0.07	0.71	0.65–0.77
		P	1.01	0.16	1.01	0.92–1.15
		Buccal	0.94	0.08	0.93	0.90–0.97

the MB canal, the smallest dentin thickness measurement was on the mesial surface of the apical third with a mean of 0.55 ± 0.04 mm. In the DB canal, the cervical third presented the smallest dentin thickness on the P surface (0.62 ± 0.02 mm). Similarly, in the P canal, a lower measurement was found on the buccal surface of the cervical third with a mean of 0.62 ± 0.02 mm.

Table 4 to 6 illustrates the measurement of dentin thickness in millimeters of the primary mandibular first molars canals (MB,

Table 4: Measurement of dentin thickness in millimeters of primary mandibular first molar in MB canal, thirds, and surfaces ($n = 15$)

Canal	*Third*	*Surface*	*Mean*	*Standard deviation*	*50th percentile*	*Interquartile range*
MB	Cervical	Mesial	1.25	0.05	1.24	1.21–1.30
		D	0.97	0.11	0.93	0.89–1.1
		Lingual	0.42	0.07	0.42	0.36–0.48
		Buccal	1.53	0.04	1.53	1.51–1.57
	Middle	Mesial	0.99	0.04	1.01	0.97–1.03
		D	0.89	0.06	0.90	0.85–0.93
		Lingual	0.44	0.06	0.43	0.39–0.49
		Buccal	1.33	0.07	1.32	1.28–1.38
	Apical	Mesial	0.80	0.04	0.81	0.77–0.82
		D	0.75	0.07	0.75	0.70–0.80
		Lingual	0.41	0.07	0.42	0.36–0.45
		Buccal	0.97	0.08	0.96	0.90–1.00

Table 5: Measurement of dentin thickness in millimeters of primary mandibular first molar in ML canal, thirds, and surfaces ($n = 15$)

Canal	*Third*	*Surface*	*Mean*	*Standard deviation*	*50th percentile*	*Interquartile range*
ML	Cervical	Mesial	1.18	0.23	1.25	0.98–1.34
		D	0.86	0.05	0.85	0.82–0.91
		Lingual	1.50	0.07	1.50	1.45–1.56
		Buccal	0.42	0.07	0.42	0.36–0.48
	Middle	Mesial	0.79	0.04	0.79	0.76–0.82
		D	0.83	0.08	0.85	0.79–0.90
		Lingual	0.99	0.10	0.95	0.90–1.10
		Buccal	0.44	0.06	0.43	0.39–0.49
	Apical	Mesial	0.67	0.04	0.68	0.63–0.71
		D	0.53	0.07	0.52	0.48–0.60
		Lingual	0.80	0.07	0.81	0.78–0.83
		Buccal	0.41	0.07	0.41	0.36–0.49

Table 6: Measurement of dentin thickness in millimeters of primary mandibular first molar in D canal, thirds, and surfaces ($n = 15$)

Canal	*Third*	*Surface*	*Mean*	*Standard deviation*	*50th percentile*	*Interquartile range*
D	Cervical	Mesial	1.03	0.15	0.98	0.91–1.19
		D	0.96	0.10	0.93	0.89–1.00
		Lingual	1.42	0.09	1.43	1.36–1.50
		Buccal	1.62	0.07	1.61	1.58–1.69
	Middle	Mesial	0.87	0.18	0.85	0.72–0.95
		D	0.72	0.07	0.71	0.66–0.78
		Lingual	1.21	0.10	1.26	1.18–1.28
		Buccal	1.46	0.13	1.47	1.34–1.56
	Apical	Mesial	0.76	0.14	0.75	0.62–0.84
		D	0.67	0.11	0.67	0.61–0.74
		Lingual	0.95	0.12	0.91	0.84–1.09
		Buccal	0.85	0.06	0.84	0.80–0.91

ML, and D), thirds, and surfaces (mesial, D, lingual, and buccal). We found that in the MB and ML canals, the smallest dentin thickness measurement was obtained in the apical third on its lingual surface (0.41 ± 0.07 mm). Similarly, in the D canal, a lower measurement was found in the apical third of the D surface (0.67 ± 0.11 mm).

Discussion

Our study is the first to report the dentin thickness of root canal walls at the cervical, middle, and apical third and mesial, D, P/lingual, and buccal surfaces of maxillary and mandibular primary first molars through a CBCT.

This study has shown the average dentin thickness of the primary root canal wall in millimeters, which can be informative and serve as a referential point for the biomechanical instrumentation (manual or rotary) of root canal treatments in primary teeth. Also, it complements previous studies on primary root anatomy and canal configuration.[12,13,29] Espinoza et al. reported findings related to root canal diameter, with a value of 0.27 mm at the apical level (the lowest average) and 0.98 mm at the cervical level (the highest in the primary maxillary first molar).[12] Montoya et al. evaluated root canal diameter using a microscopic technique and found values ranging from 0.50 mm at the cervical level, 0.38 mm in the middle third, and 0.19 mm in the apical third.[13] However, pulp treatment guidelines do not define the canal thickness for instrumentation to obtain optimal obturation.[3] Generally the files used in mesial, lingual, and buccal canals correspond to a #25 file and in D and palatine canals to a #30 file.[30,31] Therefore, our findings could enable the delimitation of the file size employed during pulpectomy procedures and reduce the risk of canal perforation or over-instrumentation.

Additionally, Baik et al. highlight that prior to any pulp procedure, specialists should know the anatomy of primary root canals to avoid certain complications that may put the permanent tooth germ at risk.[32] Ahmed et al.[29] mentions that the changes and internal root anatomical variability of the primary molar may be due to physiological resorption and deposition of additional dentin. These changes may occur in the number, shape, and even the size of the root canal. Researchers support the importance of understanding the anatomical configuration of the root and root canal. One of the reasons is their great variability and that it will serve for the clinical development of pulpal therapies by providing an average of the instrumentation to be performed.[33]

One of the main limitations encountered was that the literature focuses on permanent dentition. Therefore, the collection of information and comparison with other studies on the primary dentition was cumbersome. However, when comparing the study with other studies related to the objective, reference is made to the anatomical variations of the root canals of primary first molars, mostly with accessory canals. Likewise, another limitation was related to data collection since the sample consisted of 30 CBCT scans and most of the primary molars presented root resorption and fracture, among other factors.

According to our findings, we suggest researchers continue to evaluate the dentin thickness of root canal walls of primary teeth and establish a protocol for the clinical management of root canals (especially on biomechanical instrumentation). As such, the success rate of the treatment would increase, presenting optimal results, and benefiting the quality of life of the pediatric patient.

Conclusion

Based on the results of this study, the following conclusions can be made:

- Knowledge of the root anatomy of primary teeth allows the pediatric dentist to make better clinical decisions and reduce possible risks during root canal treatment.
- The findings of the dentin thickness of the root canal walls of the primary first molars provide fundamental evidence to complement the clinical management of pulpectomies.

Clinical Significance

Pulpectomy is among the most challenging procedures in pediatric dentistry and the knowledge of the root anatomy of primary teeth allows the professional to make better clinical decisions and reduce possible risks during root canal treatment.

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