

## Qualitative and Quantitative Micro-CT Analysis of Natal and Deciduous Teeth: A Pilot Comparative Study.

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### ABSTRACT

Background: Natal teeth are uncommon developmental anomalies present at birth or erupting within the first month of life. Due to their premature eruption and altered developmental processes, natal teeth often exhibit structural and mineralization differences compared to normal deciduous teeth. Micro-computed tomography (micro-CT) offers a non-destructive, high-resolution imaging modality for evaluating dental hard tissues quantitatively and qualitatively. Aim: To compare the morphological characteristics, mineralization patterns, and microstructural properties of natal and deciduous teeth using qualitative and quantitative micro-CT analysis. Materials and Methods: One extracted natal tooth and one extracted deciduous tooth were analyzed using high-resolution micro-computed tomography. Scanning was performed at 90 kV and 100  $\mu$ A with an isotropic voxel size of 9.9994  $\mu$ m using a 0.5-mm aluminum filter. Qualitative assessment included evaluation of enamel morphology, dentin architecture, enamel-dentin junction (EDJ), and pulp morphology. Quantitative analysis was performed using CTAn software to determine total volume of interest (TV), object volume (Obj.V), percentage object volume (Obj.V/TV), object surface area (Obj.S), object surface-to-volume ratio (Obj.S/Obj.V), and object surface density (Obj.S/TV). Results: The natal tooth demonstrated reduced mineralized tissue volume, decreased surface density, and increased surface-to-volume ratio compared to the deciduous tooth. The deciduous dentin exhibited the highest object volume (119.50  $\mu$ m<sup>3</sup>) and surface density (0.1597), indicating greater mineralization and structural maturity. Qualitative analysis revealed irregular enamel thickness and reduced dentin deposition in the natal tooth. Conclusion: Micro-CT analysis demonstrated significant structural and mineralization differences between natal and deciduous teeth. Natal teeth exhibited immature mineralized tissues with reduced density and altered morphology, whereas deciduous teeth showed greater mineralization and structural organization...

**Keywords:** Natal teeth, deciduous teeth, micro-computed tomography, enamel, dentin, mineral density..

### INTRODUCTION

Dental development is a complex biological process that begins during embryogenesis and continues throughout childhood. Natal teeth, defined as teeth present at birth, occur rarely with an estimated incidence ranging from 1:2,000 to 1:3,500 live births. These teeth commonly occur in the mandibular anterior region and frequently demonstrate developmental abnormalities including hypomineralization, incomplete root formation, and altered morphology.

The etiology of natal teeth remains incompletely understood, although genetic predisposition, endocrine influences, superficial positioning of tooth germs, and environmental factors have been proposed. Because natal teeth erupt before completion of normal mineralization processes, they often exhibit structural defects that may influence their clinical prognosis and management.

Micro-computed tomography (micro-CT) has emerged as a valuable imaging modality for investigating dental hard tissues. Unlike conventional histological methods, micro-CT enables non-destructive three-dimensional evaluation of internal and external tooth structures with high spatial resolution. This technique allows accurate assessment of enamel thickness, dentin volume, mineral density, and microstructural organization..

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Several studies have demonstrated that natal teeth possess lower mineral density and incomplete tissue maturation compared with primary teeth. However, comprehensive quantitative and qualitative comparisons between natal and deciduous teeth remain limited. Therefore, the present pilot study aimed to evaluate the structural and mineralization characteristics of natal and deciduous teeth using high-resolution micro-CT analysis.

**Materials and Methods**

**Study Design**

This pilot comparative study included one extracted natal tooth and one extracted deciduous tooth obtained following informed consent from parents or legal guardians. Ethical approval was obtained from the Institutional Ethics Committee.

**Sample Preparation**

Following extraction, all specimens were cleaned of debris and stored in physiologic saline until analysis. Samples were examined for gross defects prior to micro-CT scanning.

**Micro-CT Scanning Protocol**

Micro-computed tomography scanning was performed using a high-resolution micro-CT scanner. The scanning parameters were standardized as follows:

Parameter	Value
Voltage	90 kV
Current	100 $\mu$ A
Filter	0.5 mm Aluminum
Voxel size	9.9994 $\mu$ m
Rotation	360°
Rotation step	0.5°

The reconstructed images were generated using NRecon software after correction for beam hardening and ring artifacts.

**Qualitative Analysis**

Cross-sectional and three-dimensional reconstructed images were examined for:

- Enamel thickness and continuity
- Dentin morphology
- Enamel-dentin junction characteristics
- Pulp chamber morphology
- Degree of mineralization
- Structural defects

Two calibrated observers independently evaluated all images.

**Quantitative Analysis**

Quantitative analysis was performed using CTAn software. Regions of interest (ROI) were selected for enamel and dentin separately. The following parameters were analyzed:

- Total Volume (TV)

- Object Volume (Obj.V)
- Percentage Object Volume (Obj.V/TV)
- Object Surface Area (Obj.S)
- Surface-to-Volume Ratio (Obj.S/Obj.V)
- Surface Density (Obj.S/TV)

**Results**

**Qualitative Micro-CT Findings**

The natal tooth exhibited irregular enamel morphology with incomplete mineralization. The enamel-dentin junction appeared less distinct compared to the deciduous tooth. Dentin thickness was considerably reduced, and areas of discontinuity were observed.

In contrast, the deciduous tooth demonstrated uniform enamel thickness, well-organized dentin structure, and a clearly demarcated enamel-dentin junction. The mineralized tissues appeared more homogeneous and mature.

**Quantitative Micro-CT Findings**

**Table 1. Three-dimensional micro-CT analysis of enamel and dentin**

Parameter	Natal Enamel	Natal Dentin	Deciduous Enamel	Deciduous Dentin
Total VOI Volume ( $\mu\text{m}^3$ )	2265.26	2265.26	3668.99	3668.99
Object Volume ( $\mu\text{m}^3$ )	2.36	10.82	39.32	119.50
Object Volume (%)	0.10	0.48	1.07	3.25
Surface Area ( $\mu\text{m}^2$ )	62.06	151.10	372.01	585.91
Surface/Volume Ratio	26.29	13.96	9.46	4.90
Surface Density	0.0279	0.0667	0.1013	0.1597

**Object Volume Analysis**

The deciduous dentin exhibited the highest object volume ( $119.50 \mu\text{m}^3$ ), whereas natal enamel demonstrated the lowest object volume ( $2.36 \mu\text{m}^3$ ). These findings indicate significantly reduced mineralized tissue deposition in natal teeth.

**Object Surface Analysis**

The surface area increased progressively from natal enamel to deciduous dentin. The higher surface area observed in deciduous tissues suggests greater structural development and mineralization.

**Surface-to-Volume Ratio**

Natal enamel demonstrated the highest surface-to-volume ratio (26.29), indicating a thinner and less compact structure.

Conversely, deciduous dentin exhibited the lowest ratio (4.90), reflecting a mature and highly mineralized architecture.

### Surface Density

Surface density was lowest in natal enamel (0.0279) and highest in deciduous dentin (0.1597), further supporting increased mineralization in deciduous teeth.

### Discussion

Natal teeth represent prematurely erupted teeth that often exhibit developmental immaturity due to incomplete mineralization. The present micro-CT findings revealed considerable differences between natal and deciduous teeth in terms of volume, density, and structural organization.

Qualitative analysis demonstrated irregular enamel deposition and reduced dentin formation in the natal tooth. These findings corroborate those of Park et al., who reported hypoplastic enamel and incomplete dentin development in natal teeth. Similarly, Bijle et al. observed significantly lower mineral density values in natal teeth using micro-CT imaging.

The quantitative findings showed markedly lower object volume and surface density values in natal enamel and dentin compared to deciduous tissues. These observations may be explained by the interruption of normal odontogenesis before complete maturation of the hard tissues.

The elevated surface-to-volume ratio observed in natal enamel indicates a porous and less compact structure, consistent with previous studies reporting reduced crystallinity and mineral content in natal teeth. In contrast, deciduous dentin exhibited greater mineralization and structural maturity, reflecting completion of physiological tooth development.

Micro-computed tomography proved to be a valuable non-destructive tool for assessing early dental development. The three-dimensional evaluation enabled precise characterization of enamel and dentin morphology, which cannot be achieved through conventional histological methods.

The principal limitation of this study is the small sample size. Therefore, the findings should be interpreted as preliminary observations requiring validation in larger studies.

### Limitations

Small sample size (n=2).

Findings represent an exploratory pilot investigation.

Statistical analysis was not performed due to limited sample availability.

Further studies with larger sample populations are required.

### Conclusion

This pilot micro-CT study demonstrated substantial differences between natal and deciduous teeth. Natal teeth exhibited lower mineralized tissue volume, reduced surface density, increased surface-to-volume ratio, and altered structural morphology, indicating incomplete maturation. In contrast, deciduous teeth showed greater mineralization, increased structural organization, and enhanced tissue density. These findings contribute to a better understanding of early dental development and may aid clinicians in the diagnosis and management of natal teeth...

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