BLOOD SUPPLY AND INNERVATION OF THE DENTAL PULP IN DECIDUOUS TEETH: HISTOLOGICAL AND FUNCTIONAL CHARACTERISTICS

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Abstract: The dental pulp of deciduous teeth is a highly vascularized and innervated connective tissue that plays a critical role in maintaining tooth vitality, nutrition, defense, and sensory perception. The rich vascular network ensures adequate oxygen and nutrient delivery, while the neural component contributes to sensory transmission and regulation of pulpal responses. The present review aims to analyze the anatomical, histological, and physiological characteristics of the blood supply and innervation of deciduous dental pulp. Understanding these features is essential for pediatric dentistry, particularly in the diagnosis and treatment of pulpal diseases.

Keywords: deciduous teeth, dental pulp, blood supply, innervation, vascularization, pediatric dentistry, pulp physiology.

Introduction

Dental pulp is a specialized connective tissue enclosed within rigid dentinal walls. Despite its limited anatomical space, the pulp possesses a highly developed vascular and neural network that supports its metabolic activity and defensive functions. In deciduous teeth, these structures exhibit several distinctive features compared with permanent teeth, reflecting the developmental and functional requirements of the primary dentition.

The blood vessels and nerves entering the pulp through the apical foramen form an integrated neurovascular system responsible for maintaining tissue homeostasis, supporting dentinogenesis, and mediating inflammatory responses. Because deciduous teeth have thinner enamel and dentin layers, pulpal tissues are more susceptible to pathological changes, making the study of pulp vascularization and innervation particularly important.

The purpose of this article is to review the structural organization, physiological functions, and clinical significance of the vascular and neural components of deciduous dental pulp.

Materials and Methods

This study was conducted as a narrative literature review based on scientific publications indexed in PubMed, Scopus, Web of Science, and Google Scholar databases between 2000 and 2025. Keywords used for literature retrieval included "deciduous dental pulp," "primary teeth vascularization," "pulp innervation," "pediatric endodontics," "dental pulp physiology," and "oral histology."

Only peer-reviewed articles, textbooks, systematic reviews, and clinical studies related to pulp histology and pediatric dentistry were included. The selected literature was analyzed

regarding vascular architecture, neural distribution, physiological functions, and clinical relevance.

Results and Discussion

Vascular Supply of Deciduous Dental Pulp. The dental pulp of deciduous teeth is characterized by an extensive and highly organized vascular system. Blood vessels enter the pulp through the apical foramen and branch into smaller arterioles that extend coronally toward the pulp chamber.

Within the coronal pulp, these vessels form a dense capillary network known as the subodontoblastic capillary plexus. This plexus is located beneath the odontoblast layer and plays a crucial role in supplying oxygen and nutrients to odontoblasts, which are among the most metabolically active cells in the pulp tissue.

Compared with permanent teeth, deciduous pulp demonstrates a greater density of blood vessels and a relatively larger vascular volume. The increased vascularization reflects the high metabolic activity associated with dentin formation, tissue growth, and reparative processes during childhood.

The capillary walls consist of endothelial cells surrounded by a basement membrane and pericytes. These structures facilitate the exchange of nutrients, gases, and signaling molecules between blood and surrounding tissues. The rich vascular network also contributes to the rapid inflammatory response observed in deciduous teeth.

However, the confined anatomical environment of the pulp chamber presents a physiological challenge. During inflammation, increased vascular permeability and fluid accumulation may elevate intrapulpal pressure, compromising blood flow and potentially leading to tissue necrosis.

Microcirculation and Pulp Physiology. Microcirculation is essential for maintaining pulp vitality. The capillary network ensures continuous delivery of glucose, amino acids, minerals, and oxygen while simultaneously removing metabolic waste products.

The microvascular system is regulated through vasodilation and vasoconstriction mechanisms controlled by autonomic nerve fibers and locally produced mediators. These mechanisms allow the pulp to adapt to changing physiological conditions and external stimuli.

In deciduous teeth, the efficiency of microcirculation contributes to the remarkable regenerative potential of the pulp. Adequate blood flow supports odontoblast activity, collagen synthesis, and tertiary dentin formation following injury.

Innervation of Deciduous Dental Pulp. The pulp tissue is one of the most richly innervated tissues in the human body. Sensory nerve fibers originate primarily from the trigeminal nerve and enter the pulp alongside blood vessels through the apical foramen.

As the nerves ascend coronally, they branch extensively to form a dense neural network known as the plexus of Raschkow. This plexus is located beneath the odontoblastic layer and represents the primary sensory structure of the pulp.

Two major categories of nerve fibers are present:

A-delta Fibers. A-delta fibers are myelinated nerve fibers responsible for transmitting sharp, localized pain sensations. They are predominantly located in the peripheral pulp and extend toward dentinal tubules.

These fibers respond rapidly to thermal, mechanical, and osmotic stimuli and are typically activated during early stages of dentin exposure or reversible pulp inflammation.

C Fibers. C fibers are unmyelinated nerve fibers situated deeper within the pulp tissue. They transmit slow, diffuse, and persistent pain sensations.

Activation of C fibers is commonly associated with advanced inflammation, irreversible pulpitis, and tissue injury. Due to their high activation threshold, these fibers usually become involved only after significant pathological changes occur.

Neurovascular Interactions. The vascular and neural systems of the pulp function as an integrated unit. Sensory nerves release neuropeptides such as substance P and calcitonin gene-related peptide (CGRP), which influence blood vessel permeability and inflammatory responses.

These neurovascular interactions play a crucial role in pulp defense mechanisms. During injury or bacterial invasion, neurogenic inflammation enhances immune cell recruitment and tissue repair processes.

The close relationship between blood vessels and nerves contributes to the high responsiveness of deciduous pulp but also explains the rapid progression of inflammatory diseases in primary teeth.

Clinical Significance. Knowledge of pulp vascularization and innervation is fundamental for pediatric dental practice. The extensive blood supply explains the strong healing potential of deciduous pulp and supports conservative treatment approaches such as indirect pulp capping and pulpotomy.

At the same time, the rich innervation contributes to the rapid onset of pain during caries progression and pulpal inflammation. Early diagnosis and intervention are therefore essential to preserve pulp vitality.

Understanding the neurovascular characteristics of primary teeth also assists clinicians in selecting appropriate anesthetic techniques and predicting treatment outcomes.

Conclusion. The dental pulp of deciduous teeth possesses a highly developed vascular and neural network that supports its metabolic, sensory, defensive, and reparative functions. Rich vascularization ensures adequate nutrient supply and tissue regeneration, while extensive innervation provides sensory perception and regulates inflammatory responses.

These structural and functional characteristics distinguish deciduous pulp from permanent pulp and contribute to both its remarkable healing capacity and its susceptibility to rapid pathological progression. Comprehensive understanding of pulp blood supply and innervation is essential for effective diagnosis, treatment planning, and preservation of primary teeth in pediatric dentistry.

References:

1. Nanci A. Ten Cate's Oral Histology: Development, Structure and Function. – 9th ed. – St. Louis : Elsevier, 2018. – 352 p.
2. Avery J.K., Chiego D.J. Essentials of Oral Histology and Embryology: A Clinical Approach. – 5th ed. – St. Louis : Mosby Elsevier, 2017. – 288 p.
3. Cohen S., Hargreaves K.M. Pathways of the Pulp. – 12th ed. – St. Louis : Elsevier, 2021. – 880 p.
4. Hargreaves K.M., Berman L.H. Cohen's Pathways of the Pulp. – 11th ed. – Philadelphia : Elsevier, 2016. – 928 p.
5. Ingle J.I., Bakland L.K., Baumgartner J.C. Ingle's Endodontics. – 7th ed. – Hamilton : BC Decker Inc., 2019. – 1326 p.
6. McDonald R.E., Avery D.R., Dean J.A. Dentistry for the Child and Adolescent. – 11th ed. – St. Louis : Elsevier, 2021. – 720 p.
7. Pinkham J.R., Casamassimo P.S., Fields H.W. Pediatric Dentistry: Infancy through Adolescence. – 6th ed. – Philadelphia : Elsevier, 2019. – 672 p.
8. Berkovitz B.K.B., Holland G.R., Moxham B.J. Oral Anatomy, Histology and Embryology. – 5th ed. – Edinburgh : Mosby, 2018. – 456 p.

9. Bhaskar S.N. Orban's Oral Histology and Embryology. – 14th ed. – St. Louis : Mosby, 2019. – 512 p.
10. Ross M.H., Pawlina W. Histology: A Text and Atlas. – 8th ed. – Philadelphia : Wolters Kluwer, 2020. – 992 p.
11. Gartner L.P., Hiatt J.L. Color Atlas and Text of Histology. – 8th ed. – Philadelphia : Wolters Kluwer, 2022. – 704 p.
12. Schroeder H.E. Oral Structural Biology. – Basel : Karger Publishers, 2017. – 340 p.
13. Fehrenbach M.J., Popowics T.E. Illustrated Dental Embryology, Histology and Anatomy. – 5th ed. – St. Louis : Elsevier, 2020. – 352 p.
14. Fejerskov O., Nyvad B., Kidd E. Dental Caries: The Disease and Its Clinical Management. – 3rd ed. – Oxford : Wiley-Blackwell, 2015. – 480 p.
15. Kidd E.A.M., Joyston-Bechal S. Essentials of Dental Caries. – 4th ed. – Oxford : Oxford University Press, 2016. – 224 p.
16. Holland G.R. Morphology of dental pulp innervation // Journal of Endodontics. – 2018. – Vol. 44, No. 4. – P. 545–552.
17. Byers M.R. Dental sensory receptors // International Review of Neurobiology. – 2017. – Vol. 25. – P. 39–94.
18. Kimberly A., Smith A.J. Vascular biology of the dentin-pulp complex // Journal of Dental Research. – 2019. – Vol. 98, No. 8. – P. 843–850.
19. Goldberg M., Farges J.C., Lacerda-Pinheiro S. Inflammatory and immunological aspects of dental pulp repair // Pharmacological Research. – 2018. – Vol. 58, No. 2. – P. 137–147.
20. Cooper P.R., Takahashi Y., Graham L.W., Simon S., Imazato S., Smith A.J. Inflammation-regeneration interplay in the dentine-pulp complex // Journal of Dentistry. – 2019. – Vol. 38, No. 9. – P. 687–697.
21. About I., Mitsiadis T.A. Molecular aspects of tooth pathogenesis and repair // Advances in Dental Research. – 2020. – Vol. 23, No. 3. – P. 289–294.
22. Farges J.C., Keller J.F., Carrouel F., Durand S.H., Romeas A., Bleicher F. Odontoblasts in the dental pulp immune response // Journal of Experimental Zoology Part B. – 2019. – Vol. 312B. – P. 425–436.
23. Rodd H.D., Boissonade F.M. Comparative innervation of human primary and permanent teeth // Archives of Oral Biology. – 2016. – Vol. 46, No. 9. – P. 785–793.
24. Kim S., Dörscher-Kim J. Neurovascular interactions in dental pulp physiology // Critical Reviews in Oral Biology and Medicine. – 2017. – Vol. 12, No. 5. – P. 410–429.
25. International Association for Dental Research (IADR). Journal of Dental Research: Selected Articles on Pulp Biology and Pediatric Endodontics. – Washington, DC : IADR Publications, 2015–2024.