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Equine Periodontal Anatomy

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Take Home Message

The equine periodontium possess remarkable regenerative properties.

Introduction

The periodontium is constituted of four components: the alveolar bone, the dental cementum, the periodontal ligament (PDL), and the gingiva. The PDL is a fibrous connective tissue interposed between the dental cementum and the alveolar bone.\textsuperscript{1,2} It provides fixation of the tooth and withstands masticatory forces at the same time.\textsuperscript{3} These functional requirements are met by a unique architecture of a collagen fiber bundle system in combination with an ample blood vascular system.\textsuperscript{4-6}

Due to the lifelong eruption of the equine tooth the equine PDL has to provide mechanisms for continuous tissue remodeling and tissue repair.

The aim of the present series of studies was thus to identify specific components and mechanisms of the equine PDL that are involved in tooth support, acceptance of forces, tissue remodeling and tissues repair.

Investigations were focused on:

- the collagen fiber apparatus, i.e. its spatial arrangement, its changes during the process of tooth eruption, and its mechanisms of remodeling,
- the blood vascular system and lymph vascular system, i.e. their organisation, and their interactions with the collagen fiber apparatus,
- the cells of the periodontal ligament, i.e. their ability for proliferation and differentiation.

Materials and Methods

In a series of studies the equine periodontium has been investigated using histological methods, immunohistochemical stainings, vascular casting techniques and cell biological methods.

Results

Tooth support is achieved by collagen fiber bundles aligned in multidirectional arrangements.\textsuperscript{6} Thus, intrusive movements of the tooth and the sideward motion during the equine laterolateral...
chewing cycle cause tensile load only in distinct groups of fiber bundles. Eruption is assured by a well-coordinated remodeling of the periodontal fiber apparatus. Collagen degradation is initiated by matrixmetalloproteinase-1 and occurs only within certain single fiber bundles. In this way the function of tooth support is always maintained while the collagen apparatus is submitted to remodeling in order to become adapted to the dynamic morphological changes.

The **blood vascular system** is a well adapted arrangement consisting of an inner capillary layer (near the tooth) and an outer venous layer (near the alveolar bone). This system contains specific vascular structures, i.e. blind vessels and large ampullae, but no venous valves. These structural features provide the requirements for the distinct functions of the blood vascular system, like nutrition and shock absorbency. Furthermore, it is assumed that the vascular system facilitates an intra-extravasal shift of fluids in order to generate hydrostatic pressures necessary for tooth eruption.

Characteristic **fibro-vascular arrangements** apparently meet the biomechanical requirements of the PDL during the chewing cycle. In a so-called type-I arrangement, a sheath of fibers and cells protects the blood vessels from the deformations of the surrounding tissue. In a type-II arrangement, tractive forces in collagen fibers are transferred to compress adjacent blood vessels (by what is called a lateral compression mechanism); in a type-III arrangement wide venules are assumed to act as a hemodynamic cushion, and collagen fibers prevent the vessels from shifting. The distinct combination of the physical properties of the collagen fibers (i.e. elasticity) and the intravasal blood content (i.e. viscosity) forms a visco-elastic system.

Initial **lymphatic vessels** are present in the PDL and in the adjacent bony spongiosa of the jaws. Their distribution leads to the assumption of two alternative ways of lymphatic drainage: ventrally into the mandibular lymph nodes, and caudally into the retropharyngeal lymph nodes.

The **periodontal cells** play a pivotal role in regulation and orchestration of periodontal remodeling and repair. This is reflected by an exceptionally high rate of cell proliferation in the equine PDL compared to other species. Further, the equine PDL houses a population of defined multipotent mesenchymal stromal cells which are capable of differentiation into certain cell lineages.

**Discussion**

The most notable aspect of the equine PDL is the constant, essential process of **tissue remodeling**, which is necessary for the continuous eruption of teeth. It is also an indicator of the high capability for regeneration and repair of the periodontal tissues. By utilizing the PDL specific multipotent mesenchymal stromal cells new therapeutic concepts in equine dentistry and periodontology might be available in the future.

**References**