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Letter to Editor

Dentistry Section

Exploring Matrix Metalloproteinases in Children's Oral Health: Mechanisms, Implications and Therapeutic Insights

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Dear Editor,

The oral cavity is recognised as a dynamic environment where various physiological processes are set in motion during the course of a child's development. These processes include significant events such as tooth eruption, gingival development, and tissue repair [1]. Within this intricately orchestrated scenario, Matrix Metalloproteinases (MMPs) are identified as pivotal participants [2]. MMPs comprise a family of enzymes that are widely acknowledged for their engagement in the degradation of the Extracellular Matrix (ECM) and the remodelling of tissues, both of which are fundamental processes in the maintenance of tissue homeostasis. Nevertheless, the equilibrium overseen by MMPs has the potential to be disrupted, thus giving rise to the possibility of oral diseases manifesting in paediatric patients.

The MMPs, as zinc-dependent endopeptidases, hold central roles in the remodelling of the ECM, a critical aspect of maintaining oral tissue integrity. These enzymes are initially secreted as inactive proenzymes, becoming active upon cleavage of their propeptide domain. MMPs are further categorised based on their substrate specificity, encompassing collagenases, gelatinases, stromelysins, and membrane-type MMPs. They emanate from various cell types within the oral milieu, including fibroblasts, epithelial cells, and inflammatory cells, and their activity is tightly regulated to preserve tissue integrity [3].

The primary function of MMPs in paediatric oral health revolves around tooth development and eruption. MMPs actively participate in the remodelling of the ECM within the dental follicle and alveolar bone, facilitating the emergence of primary and permanent teeth alike. Notably, gelatinases MMP-2 and MMP-9 assume a pivotal role in this context by degrading ECM components that might otherwise impede the natural eruption process, thereby ensuring teeth emerge in their correct positions within the oral cavity [4].

In addition to their involvement in tooth development, MMPs are instrumental in maintaining gingival homeostasis, a critical aspect of paediatric oral health. Gingival tissues constantly undergo turnover and remodelling to preserve their structural integrity and functionality. Within the gingival milieu, MMP-1 and MMP-8, among others, regulate collagen metabolism. This regulation is crucial for conferring stability and resilience to the gingiva, enabling it to withstand mechanical stresses and microbial challenges [5].

Furthermore, MMPs contribute significantly to the process of tissue repair within the oral cavity, a particularly relevant function in the context of paediatric dentistry. Children are susceptible to oral injuries and traumas, which may result from accidents, falls, or sports activities. In such scenarios, MMPs become activated to degrade the damaged ECM and facilitate efficient tissue healing. This function aids in the recovery of various oral tissues, including the gingiva and oral mucosa, ensuring that wounds heal effectively while minimising complications [6].

Moreover, MMPs play a noteworthy role in maintaining the equilibrium of the oral microbiome - a diverse microbial community that resides in the oral cavity. Maintaining this balance is crucial for overall oral health. MMPs contribute to regulating the oral microbial environment through their involvement in the turnover of the oral mucosa and supporting tissues. This regulation serves to sustain a state of equilibrium within the oral microbiome, preventing the overgrowth of harmful bacteria that may lead to common dental diseases like dental caries and periodontal diseases [7,8].

Switching gears, MMPs also play a pivotal role in orthodontic treatment for children. They are involved in remodelling tissues during tooth movement, breaking down and rebuilding ECM components like collagen and proteoglycans. This enzymatic activity ensures precise tooth movement within the bone, a critical aspect of orthodontic treatment. Additionally, MMPs aid in adapting periodontal tissues to orthodontic forces, contributing to a stable occlusion after treatment. However, it's crucial to carefully regulate MMP activity to prevent adverse effects like root resorption, ensuring the child's oral health is optimised [9].

A profound understanding of how MMPs influence tooth eruption, gingival health, tissue repair, and microbial balance equips paediatric dentists with invaluable insights for refining diagnostic and treatment strategies. This knowledge empowers dental professionals to enhance their management and preventive measures concerning paediatric dental issues, including dental caries, periodontal diseases, and malocclusion. Consequently, deciphering the multifaceted role of MMPs holds the potential to revolutionise treatment modalities, ushering in a new era of more effective and personalised care, ultimately securing the improved oral health and overall well-being of young patients [10].

However, it is worth noting that while the importance of MMPs in paediatric oral health is evident, the scarcity of available literature addressing their impact highlights the need for meticulously designed, long-term research studies in this field. The future of MMP research in paediatric dentistry anticipates groundbreaking discoveries that encompass early disease detection using MMP biomarkers and the development of tailored therapies to modulate MMP activity. The integration of advanced imaging techniques and molecular approaches is poised to provide a more comprehensive and personalised approach to paediatric dental care. Furthermore, interdisciplinary collaboration and the accumulation of knowledge will shape the field of MMP research, ultimately resulting in enhanced oral health outcomes and an improved quality of life for young patients.

REFERENCES

[1] Storey AT, Kenny DJ. Growth, development, and aging of orofacial tissues: Neural aspects. Adv Dent Res. 1989;3(1):14-29.
[2] Haeusler G, Walter I, Helmreich M, Egerbacher M. Localization of Matrix Metalloproteinases, (MMPs) their tissue inhibitors, and Vascular Endothelial Growth Factor (VEGF) in growth plates of children and adolescents indicates a role for MMPs in human postnatal growth and skeletal maturation. Calcif Tissue Int. 2005;76(5):326-35.

[3] Hannas AR, Pereira JC, Granjeiro JM, Tjäderhane L. The role of matrix metalloproteinases in the oral environment. Acta Odontol Scand. 2007;65(1):01-13.
[4] Kardos TB. The mechanism of tooth eruption. Br Dent J. 1996;181(3):91-95.
[5] Doufexi A, Mina M, Ioannidou E. Gingival overgrowth in children: Epidemiology, pathogenesis, and complications. A literature review. J Periodontol. 2005;76(1):03-10.
[6] Lin S, Zuckerman O, Fuss Z, Ashkenazi M. New emphasis in the treatment of dental trauma: Avulsion and luxation. Dent Traumatol. 2007;23(5):297-303.
[7] Costalonga M, Herzberg MC. The oral microbiome and the immunobiology of periodontal disease and caries. Immunol Lett. 2014;162(2):22-38.
[8] Luchian I, Goriuc A, Sandu D, Covasa M. The role of matrix metalloproteinases (MMP-8, MMP-9, MMP-13) in periodontal and peri-implant pathological processes. Int J Mol Sci. 2022;23(3):1806.
[9] Elgezawi M, Haridy R, Almas K, Abdalla MA, Omar O, Abuohashish H, et al. Matrix metalloproteinases in dental and periodontal tissues and their current inhibitors: Developmental, degradational and pathological aspects. Int J Mol Sci. 2022;23(16):8929.
[10] Ingman T, Apajalahti S, Rice D, Sorsa T. Gingival crevicular fluid, matrix metalloproteinases, and their bioactive regulators as potential adjunctive chair-side point-of-care biomarkers in orthodontic tooth movement. Semin Orthod. 2012;18(4):270-77.

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