Polyphenol-mediated oxygenating hydrogel ameliorates periodontitis by targeting stem cell senescence

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A study seeking to develop a novel therapeutic strategy for periodontitis that targeted stem cell senescence by modulating the microenvironmental cues was presented at the 102nd General Session of the IADR, which was held in conjunction with the 53rd Annual Meeting of the American Association for Dental, Oral, and Craniofacial Research and the 48th Annual Meeting of the Canadian Association for Dental Research, on March 13-16, 2024, in New Orleans, LA, U.S..

The abstract, "Polyphenol-Mediated Oxygenating Hydrogel Ameliorates Periodontitis By Targeting Stem Cell Senescence" was presented during the "Biologically Active Materials for Restorative and Regenerative Applications" Poster Session that took place on Friday, March 15, 2024 at 11 a.m. Central Standard Time (UTC-6).

The study, by Chengxinyue Ye of Sichuan University, Chengdu, China, constructed a polyphenol-mediated oxygenating hydrogel with polyphenol-mediated manganese modified calcium peroxide (CPO) nanoparticles and polyphenol-modified zeolitic imidazolate framework-8 nanoparticles incorporated into silk fibroin methacrylate matrix.

The in vitro biocompatibility, anti-senescent and immunomodulatory effect of the hydrogel was evaluated by applying on human-derived periodontal ligament stem cells (hPDLSC) as well as macrophages in a liposaccharide-induced pro-inflammatory microenvironment. The in vivo therapeutic effectiveness was assessed with a rat ligature-induced periodontitis model.

The polyphenol-based modification strategy endowed the hydrogel with promoted oxygen production, antioxidant capability and moderate mechanical properties. The hydrogel downregulated markers of senescence (senescence associated β-galactosidase activity, P16 and P21

expression), reduced senescence-associated secretory phenotype expression, scavenged intracellular reactive oxygen species, as well as promoted proliferation and osteogenic differentiation capability in inflamed hPDLSC. The hydrogel also exhibited immunomodulatory effect by curbing pro-inflammatory cytokines expression in macrophages and driving the macrophage polarization toward M2 phenotype.

The hydrogel facilitated both alveolar bone and periodontal ligament regeneration in rat periodontitis, presenting a synergistic effect of alleviating local hypoxia, inhibiting inflammatory responses and suppressing cellular senescence. The polyphenol-mediated oxygenating hydrogel effectively boosted periodontal regeneration by reversing the inflamed and hypoxic microenvironment and suppressing stem cell senescence. This study provided a novel anti-senescent therapy for periodontitis and casted new light on prospective regenerative material designing.

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