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Polymeric Nanoparticles for Chemokine Mediated Dental Pulp Tissue Engineering

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Objectives Small molecules like chemokines, growth factors, and cytokines can stimulate endogenous cell migration to injury sites and initiate wound healing. However, using molecules such as chemokines comes with many hurdles due to their instability, short half-life, and sensitivity to enzymatic degradation. This study aims to develop polymeric nanoparticles (NPs) for chemokine encapsulation and efficient delivery.

Methods Medium molecular weight chitosan (CS) was mixed with tripolyphosphate (TPP), and polymeric NPs were obtained by ionic gelation. After synthesis, these NPs were purified, treated with a cryoprotectant and freeze-dried. Then, NPs were redispersed, followed by dynamic light scattering (DLS) size and charge characterization. Chemical characterization was performed using Fourier-transform infrared spectroscopy (FTIR). Morphology and topography were confirmed with scanning and transmission electron microscopy (SEM & TEM). The effect of NPs on cell behaviour was assessed by NP incubation with dental pulp stem cells (DPSCs) for viability assessment at 1, 3, and 7 days.

Results The nanoparticle synthesis successfully resulted in a monodisperse solution with particles averaging a size of 180 ± 1.8 nm and a polydispersity index of 0.22. The zeta potential was stable over all measurements, with an average of 45.3 ± 0.9 mV. FTIR confirmed the presence of all chemical groups and successful ionic gelation, while both microscopy methods confirmed NP spherical morphology. Finally, cytotoxicity experiments confirmed their biocompatibility.

Conclusions Uniform and stable CS-TPP nanoparticles have been successfully synthesized. These nanoparticles have shown preliminary biocompatibility with DPSCs and will be further used for drug loading with chemokine CXCL12, allowing a unique interaction with the CXCR4 receptor expressed by DPSCs and targeting a cell-free approach for dental pulp repair and regeneration.