Injectable Hyaluronic Acid Microgel with Improved Hemocompatibility in Biomimetic Blood Flow

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Abstract

Demand for non-surgical cosmetic procedures continues to rise yearly, with cosmetic injectables – such as soft tissue fillers – leading the trend in facial volume restoration and wrinkle reduction. Presently, most clinically available injectable fillers are composed of macroscopic hyaluronic acid (HA) derived hydrogels, due to their effectiveness, safety profile, and straightforward administration. Although complications remain rare, increasing volumes of treatments have led to a corresponding rise in reported adverse cases, from allergic reactions, nodule formation and more seriously, vascular compromise. Accidental intravascular filler injections can result in tissue injury, for which no highly effective treatment currently exists.

To address this, we designed and characterised three types of HA-based hydrogel microparticles, assessing structure, rheological properties, injection administration, in vitro safety profile and drug loading capacity. The project aim was to develop a novel dermal filler, which minimises risk of vascular complications, and enhances longevity of tissue restoration. All three HA-based microparticle formulations exhibited uniform shapes and controlled diameters, with tunable viscosity, dynamic stability and dispersity in microfluidic conditions which mimic vascular flow. This demonstrated that the microgel-based formulations can be safely administered without posing significant intervascular risks. Cell viability and hemocompatibility tests showed low cytotoxicity and enhanced safety profile. Functionalisation of microgels using synthetic polymers presents a cost-effective strategy for controlling biodegradation rate of fillers, improving longevity, hemocompatibility, and applicability in surgical devices and drug delivery systems.

These findings highlight HA-based microgels as a potential next-generation alternative to conventional dermal fillers, offering safer and more versatile approaches to cosmetic and medical applications.