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Effects of enzymatic degradation on dynamic mechanical properties of the vitreous and intravitreal nanoparticle mobility

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Abstract

Intravitreal mobility of nanocarriers may have implications on the efficacy of the encapsulated drug in the treatment of vitreo-retinal diseases, with any changes in the integrity of the vitreous microstructure influencing nanoparticle biodistribution. This study investigated enzymatically digested vitreous models to mimic the aging eye. Collagenase, hyaluronidase, or trypsin was employed to selectively digest the structural components of the vitreous. Physical properties of digested bovine vitreous were initially assessed via texture analysis and oscillatory shear testing. Morphological changes in bovine vitreous microstructure were visualized by scanning electron microscopy and diffusion dynamics of hyaluronic acid coated nanoparticles through degraded porcine and bovine vitreous were examined using fluorescence spectroscopy and multiple particle tracking microscopy, respectively. After enzymatic treatment, the vitreous liquefied and its dynamic mechanical properties significantly changed with a decrease in stiffness and an increase in damping capacity. Micrographs confirmed specific digestion of each of the structural vitreous components. Furthermore, enzymatic degradation reduced steric hindrance and enhanced convective flow within the vitreous, resulting in increased intravitreal nanoparticle mobility which could alter the drug pharmacokinetics.