Restoring the Mechanical Properties of Degenerated Load-Bearing Tissue using Responsive Microgel Particles

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An important challenge to materials scientists is to provide injectable materials that enable repair of damaged and degenerated tissue. A key criterion for these materials is that their mechanical properties can be adjusted to match those of the surrounding tissue. This work presents the first study of the ability of responsive microgel particles to restore the mechanical properties of load-bearing soft tissue. Microgel particles are cross-linked polymer colloid particles that swell in a good solvent. We hypothesised that a concentrated dispersion of pH-responsive microgel particles that contained high carboxylic acid concentrations would give an injectable *fluid* at low pH that would change to a *gel* at body pH capable of supporting loads similar to those experienced by intervertebral disc (IVD) tissue in the body. The load-bearing capability would originate from the high swelling pressure of the deprotonated microgel particles. In this work model pH-responsive poly(EA/MAA/BDDA) (ethylacrylate, methacrylic acid and butanediol diacrylate) microgel dispersions were injected into degenerated bovine spinal units. Bovine spinal units (from cow tails) are a commonly used animal model for human IVDs. The compression data show that injection of the microgel dispersion and pH-induced particle swelling restores the mechanical properties of degenerated IVDs to normal values. This work demonstrates a new general approach for restoring the mechanical properties of damaged tissue that should be applicable to other soft-tissue, such as tissues below the skin and articular cartilage.