

Hydrogels have also been encapsulated with growth factors like transforming growth factor-beta (TGF- β), insulin-like growth factor-1 (IGF-1), BMP-2, commonly found in the ECM of the cartilage. These encapsulated growth factors are expected to provide a more conducive environment for the cells to grow within the hydrogel scaffold. To improve mechanical properties of hydrogel Gelatin was photo crosslinked with methacrylic acid. These gels when incorporated with TGF- β 1, showed good chondrocyte growth and proliferation along with maintenance of chondrocytic phenotype and ECM secretion (Hu et al. 2009). Kim et al. developed an oligo poly(ethylene glycol) fumarate (OPF) hydrogel and encapsulated with gelatin microparticles loaded human recombinant IGF-1 and TGF- β 3 (Kim et al. 2013). Though such a dual growth factor delivery system was expected to increase the osteochondral defect healing, single delivery of IGF-1 showed better results. Holland et al. also showed similar results (Holland et al. 2007). Furthermore, IGF-1 along with BMP-2 when encapsulated in OPF hydrogel showed a synergistic effect on the two growth factors and enhance the bone growth and repair in rabbit medial femoral condyle osteochondral defect (Lu et al. 2014). Thus it can be said that only certain combinations of growth factors interact positively with each other and show better results. Hence, optimum combinations of growth factors should be kept in mind while designing the hydrogel for enhanced tissue engineering.

Bone

Alginate hydrogels along with poly(aldehyde guluronate) (PAG) have been encapsulated with rat calvarial osteoblasts and implanted ectopically in mice. Bone tissue formation was observed at the end of nine weeks (Lee et al. 2001). RGD peptide modified alginate injectable hydrogel have also been developed to improve cell interactions and showed significant bone formation *in vivo* studies in mice (Alsberg et al. 2001). Photo-crosslinked hydrogel have been prepared with tunable biodegradation properties (Jeon et al. 2009). The use of platelet rich plasma, which is rich in growth factors, in an injectable form along with MSCs, has also been used to improve osteogenesis (Yamada et al. 2004). Kim et al. encapsulated MSCs and BMP-2 in sulfamethazine oligomers (SMOs) to both ends of a thermo-sensitive poly(ϵ -caprolactone-co-lactide)-poly(ethylene glycol)-(ϵ -caprolactone-co-lactide) (PCLA-PEG-PCLA). This injectable gel was both pH and thermoresponsive and showed mineralised tissue formation ectopically in mice (Kim et al. 2008). Similarly Kim et al. synthesised injectable acrylated HA gel-using tetrathiolated PEG as a crosslinker. This delivery system was used to deliver MSCs and BMP-2. The *in vivo* studies in rat calvarial defects showed that MSCs could differentiate into osteoblasts and endothelial cells due to the microenvironment of the site (Kim et al. 2007). Burdick et al. developed injectable RGD modified PEG hydrogel by photo-crosslinking method to encapsulate osteoblasts (Burdick et al. 2002). It was demonstrated that with RGD conjugation a large number of cells could be encapsulated and good cell attachment and spreading could be achieved within the photo cross-linked hydrogel. Chitosan has been synthesized into an *in situ* gelling system by the addition of ammonium hydrogel phosphate. By varying the phosphate salt concentration, a gelation time at 37°C could be achieved within