Microspheres to Create Gradient-Based Scaffolds and Shape-Specific Scaffolds
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Introduction
Microsphere-based scaffolds are gaining increasing interest in tissue engineering, as are gradient-based approaches for interfacial tissue engineering. The objectives of these experiments were 1) to fabricate scaffolds with engineered signal gradients, 2) to fabricate scaffolds in the presence of cells in a single step, 3) to evaluate the efficacy of the gradient plugs in vitro with stem cells, and in vivo in rabbit knee defect regeneration, and 4) to use the same basic methodology to create shape-specific scaffolds.

Materials and Methods
Monodisperse PLGA microspheres were fabricated with different growth factors or nanophase materials. Gradient scaffolds were then prepared as previously described.¹ Dense-phase CO₂ was also used as an alternative method to sinter microspheres in a 3D mold to create shape-specific scaffolds. CO₂ was also used to sinter microspheres in the presence of cells to create cell-based biomaterials in a single step.² Human umbilical cord mesenchymal stromal cells (hUCMSCs) were seeded on blank or gradient scaffolds and cultured for 6 wks. In addition, defects were created in New Zealand White rabbit knees, and filled with blank or gradient scaffolds, and evaluated after 12 wks.

Results
Porous, 3D shape-specific constructs were successfully fabricated (Fig. 1, 2), and thin patches and 3D constructs were fabricated in the presence of cells with high cell viability. In vitro, gradient scaffolds induced heterogeneous chondrogenic differentiation of hUCMSCs that was not observed in blank scaffolds. In vivo, microsphere-based scaffolds were able to fill in knee defects in rabbits after 6 wks, and gradient scaffolds produced a better response than blank scaffolds after 12 weeks.

Discussion and Conclusions
New approaches were developed to engineer opposing signal gradients, and to create cell-loaded biomaterials of desired shape in a single step.

References

Acknowledgments
We gratefully acknowledge funding from the NIH (R21-DE017673-01, R21-EB007313-01).

Disclosures
None