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A regenerative cardiac bioscaffold provides more mechanical deformation in vitro and in vivo than a commonly used non-regenerative scaffold

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Summary

Introduction: The loss of contractile myocytes in the heart, accompanied by an accumulation of scar tissue due to myocardial infarction, depresses ventricular function and leads to heart failure. Recently we have demonstrated that extracellular matrix (ECM) scaffolds replacing myocardium improve regional mechanical function and increase the number of myocytes in the patch region. Because one factor contributing to the observed cardiac regeneration may be the intrinsic mechanical properties of the ECM scaffold, we studied these characteristics using a novel membrane inflation device. We mimicked in vivo conditions using the device and then compared these results to in vivo results immediately following implantation in the beating, working heart.

Methods: The in vitro mechanical properties of Dacron and ECM scaffolds were assessed using a novel membrane inflation device. An area stretch ratio (from end diastole to end systole) was calculated for each sample. Dacron and ECM scaffolds were then implanted into 1x2cm, full-thickness, surgically created defects in the right ventricles of four canine hearts. Intracavitary ventricular pressure was measured and regional mechanical deformation determined by high-density mapping. An in vivo area stretch ratio was then calculated for comparison.

Results: The average right ventricular developed pressure for the ECM implanted hearts was 15.2 A? 1.3 mmHg, compared to 15.6 A? 1.2 mmHg for the Dacron implanted hearts (p = NS). The area stretch ratio was 7.0 A? 1.5

Discussion: These results demonstrate that Dacron and ECM scaffolds undergo vastly different changes in mechanical deformation when implanted into the beating, working heart, yielding results comparable to those obtained in vitro. As we have previously reported cardiac regeneration occurs in ECM scaffolds but not Dacron scaffolds, scaffold mechanics may be a contributing factor to regeneration.