Perforation of Acellular Dermal Matrices Increases the Rate of Cellular Invasion

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Background: There are several commercially available acellular dermal matrices (ADM), whose properties vary according to their proprietary manufacturing processes. Survival and durability of any of these ADM depends on effective host cellular invasion and neovascularization. As cellular invasion and vascularization are crucial for ADM incorporation and survival, interventions that could expedite this process should be explored. We sought to quantitatively determine whether perforating ADM scaffolds would result in more rapid host cell invasion in a murine model of graft incorporation. (1-5)

Methods: 6mm Strattice™ and Xenmatrix™ scaffolds were created using a biopsy punch and perforated with a 26G needle, resulting in an evenly distributed "spoke and wheel" pattern of 1 perforation/1mm^2 of scaffold surface area. Biomechanical testing was performed on perforated and non-perforated samples using a MTS Criterion™ Universal Test Systems machine. Scaffolds were implanted subcutaneously in the dorsa of C57BL6 mice and harvested after 14 and 28 days. Representative sections from post-harvest samples were stained for DAPI (4', 6-Diamidino-2-Phenylindole) and imaged. Scaffolds were divided into 4 layers of 50 microns with increasing depth, and cell density was calculated using ImageJ. Densities were plotted according to layer depth, yielding an exponential decay graph. Exponential regression equations were then created and used to determine an "invasion coefficient." Higher invasion coefficients correspond with increased degrees of cellular invasion in each ADM.

Results: Biomechanical testing of perforated Strattice™ and Xenmatrix™ demonstrated similar tensile strengths and failure forces when compared with their respective non-perforated samples. After 14 days, perforated Strattice™ exhibited a higher invasion coefficient when compared with non-perforated Strattice™ (0.526 vs. 0.408). Similarly, at our 14-day time-point, the invasion coefficient for perforated Xenmatrix™ was also higher when compared to non-perforated Xenmatrix™ (0.466 vs. 0.378). This trend continued at 28 days with a higher invasion coefficient seen in perforated Xenmatrix™ compared with non-perforated Xenmatrix™ (0.474 vs. 0.395).

Conclusion: We have demonstrated that perforation of ADM increases the rate of cellular invasion after both 14 and 28 days. Biomechanical testing revealed that perforating ADM did not significantly diminish its tensile strength. These findings suggest that incorporating perforations into the fabrication of ADM may significantly improve scaffold cellular invasion and decrease the time to neovascularization and incorporation. It can also lead to decreased risk of seroma and infection, drastically decreasing patient morbidity.

References:

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Disclosures

Dr. Jason Spector, MD, FACS is a consultant for Bard, Inc.