Implications of Immediate Autologous Fat Grafting and Expanded Adipose-derived Progenitor Cells on Hypertrophic Scar Maturation in a Swine Model

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Purpose:
Hypertrophic scar formation is unpredictable and poorly understood, afflicting both the pediatric and adult populations. Treatment methods with conservative and invasive approaches have low rates of compliance and high rates of morbidity. The purpose of this study is to develop a reproducible scar model and investigate a new technique of scar modification through the use of adipose-derived progenitor stromal cells (ASCs).

Methods:
20 thermal deep-partial thickness contact burns were created on the dorsum of three 8-week old domestic swine and allowed to mature for 10 weeks. Scars were then injected with 2 cc saline, expanded autologous ASCs, or 2 cc fresh lipoaspirate and sampled at 2 week intervals up to 10 weeks post injection. Volumetric analysis with a 3-D scanner, mechanical elasticity testing through negative pressure transduction, and standardized photography evaluation with Image J was performed. Biopsies were taken at 2 week intervals and histologically analyzed for collagen deposition and vascularity. RNA sequencing was performed on scar tissue samples, cultured cells, and fresh lipoaspirate.

Results:
Volumetric analysis demonstrates a reduction in average scar thickness at 6 weeks when injected with ASCs (-1.601 cc³) and autologous fat (-1.965 cc³) relative to controls (-0.121 cc³, p < 0.05). A decrease in overall tissue compliance is observed with fat or ASC injection when compared to unburned skin at 8 weeks (35.99/37.94 vs 49.36 mmHg*mm, p <0.01). Scars treated with fat or ASCs increase the rate at which erythema resolves. RNA sequencing suggests regulation of fibroblast gene expression and a decreased inflammatory profile when scars are injected with fat cells.

Conclusions:
Early results suggest that autologous fat and/or ASCs may improve healing of hypertrophic scarring by altering the cellular and structural components during wound remodeling up to 14 weeks after injury. This may have beneficial applications in early treatment of large or cosmetically sensitive immature burn scars.
Saline Injection
Untreated Scar
ASC Injection
Fat Injection
Cultured ASCs/ Fresh Fat

RNA Sequencing
Figure 1. 3-D volumetric analysis of hypertrophic scars. Scans at 2 and 4 weeks were superimposed (top left, top middle, top right) and thickness differences (arrow) calculated between time points (bottom).