Morphological Changes of Skin Related to Acellular Dermal Matrix Incorporation in Tissue Expansion

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INTRODUCTION

Acellular dermal matrix (ADM) is a human-derived soft connective tissue graft that has undergone a decellularization process to preserve the extracellular skin matrix. Previous work has demonstrated an improved aesthetic outcome with the use of ADM in two-stage tissue-expander breast reconstruction. However, the safety and efficacy of ADM remains controversial. The present study evaluates morphological and molecular changes mediated by use of ADM in a pre-pectoral model of tissue expansion (TE).

MATERIALS and METHODS

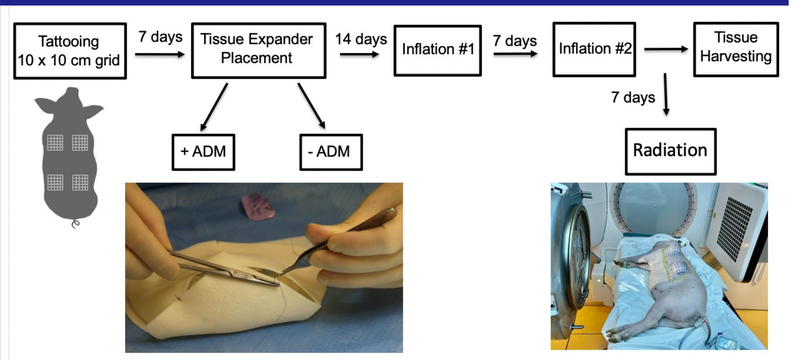

Figure 1. Outline of experimental design.

Pigs underwent tattooing and placement of subcutaneous tissue expanders, half of which were wrapped in ADM. All expanders were inflated with two weekly fills and a subset of pigs received a single fraction of 20 Gy radiation one week after the final inflation. Skin biopsies were harvested before and after radiation for histological analysis and expression of pro-apoptotic genes. A computational model and isogeometric analysis utilized 3D photos to calculate growth and stretch.

RESULTS

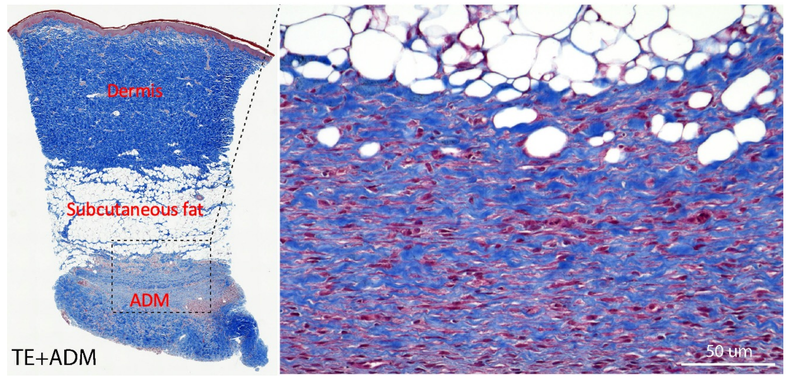

Figure 2. Trichrome staining revealed the presence of cells invading the ADM, confirming successful incorporation of ADM below the subcutaneous adipose layer.

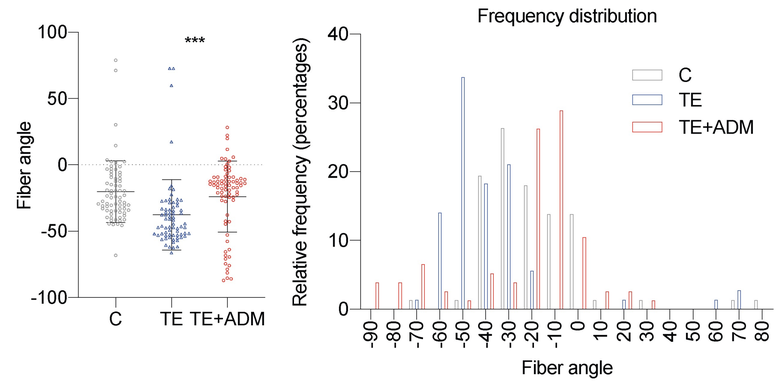

Figure 3. Average fibril orientation of collagen in the papillary dermis was estimated with respect to the x-axis. In comparison to control skin, collagen fibers in TE alone underwent greater change in their orientation than collagen fibers in TE+ADM.

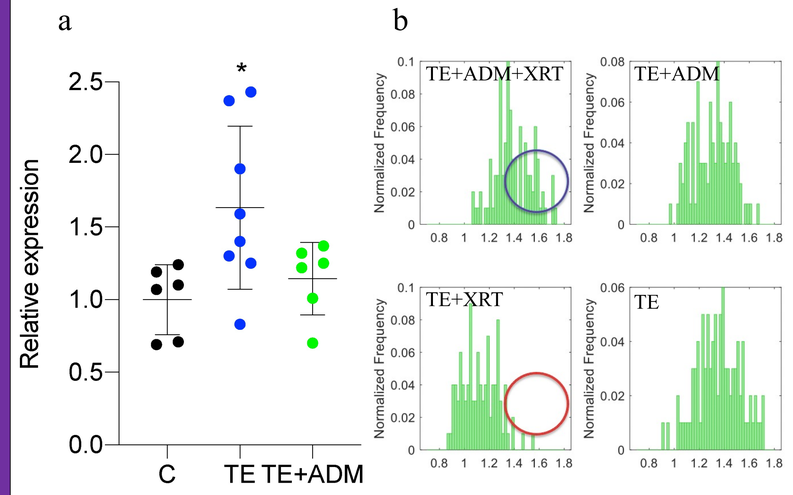

Figure 3. (a) A measure of gene expression identified higher levels of BAX, a pro-apoptotic gene, in TE than in TE+ADM. (b) In the presence of ADM, results from isogeometric analysis showed continued growth of expanded skin two months after radiation. However, in the absence of ADM, irradiated skin did not demonstrate growth at the two-month mark. The pattern of skin growth after radiation in TE+ADM most resembled skin growth in non-radiated skin.

CONCLUSIONS

- ADM appears to play a protective role in tissue expansion followed by radiation therapy.
- Successful incorporation of ADM with nearby tissue prevents architectural changes and collagen disarray observed during tissue expansion alone.
- Skin expanded in the presence of ADM expresses lower levels of BAX, a pro-apoptotic gene, thereby leading to continued skin growth despite radiation-induced injury.