Reconstruction of Parotidectomy Defects in the Rat Model: A Comparison of AlloDerm versus DermaMatrix

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ABSTRACT

Objectives: We looked to analyze tissue incorporation, immune response, and neovascularization of AlloDerm™ and DermaMatrix™ implants in the post-parotidectomy bed and dorsum.

Methods: Eight male Sprague-Dawley rats were used. In each rat, three folded AlloDerm™ implants were placed in the post-parotidectomy bed and three were placed in the dorsum as controls. The same was done for DermaMatrix™. Two animals were sacrificed at 8, 12, and 16 days. A blinded pathologist assessed the degree of fibroblast proliferation, microvessels, and inflammatory cells present in each section of implant.

Results: Significant differences between type and location of implants were more prevalent at later time points. In the parotid gland, AlloDerm™ showed higher degrees of fibroblast proliferation at eight days (p = 0.0106), with no significant differences with DermaMatrix™ in the number of inflammatory cells or degree of neovascularization. When compared with the dorsum, DermaMatrix™ implants in the parotid gland had higher numbers of inflammatory cells at eight and twelve days, with 14.17 (p = 0.0490) and 33.33 (p = 0.0046) cells per section respectively.

Conclusions: Our study showed that there are mild postoperative histologic differences between AlloDerm™ and DermaMatrix™ in the post-parotidectomy bed. The unique properties of each implant could potentially be a source of differing complication profiles in humans.

INTRODUCTION

Acellular human dermal implants like Alloderm (LifeCell Corporation, Branchburg, NJ) and DermaMatrix (Synthes Corporation), have gained popularity for reconstruction of parotidectomy defects because of good cosmetic results secondary to their space occupying effect, prevention of Frey syndrome, ease of use, variability in size and thickness, and avoidance of donor site morbidity [1-5]. Both products are derived from cadaveric skin and consist of dense collagen-based connective tissue devoid of cellular and antigenic components [6-7].

Our preliminary studies in humans have demonstrated a statistically significant higher rate of postoperative sialocele/seroma found in parotidectomies that used DermaMatrix [8]. The purpose of our study is to analyze tissue incorporation, host immune response, and neovascularization of the three-dimensionally folded acellular dermal implants, Alloderm and DermaMatrix, in a mouse model.

METHODS AND MATERIALS

Eight male Sprague-Dawley rats were used. A 1-cm incision overlying the right parotid gland was made and the skin, subcutaneous tissue, platysma muscle and SMAS fascia were elevated in a single flap. The fascia overlying the parotid gland was removed using blunt dissection. Three implants of DermaMatrix measuring 0.5 x 0.5 cm were folded once, with the coarser "dermal" side on the outside abutting the subcutaneous tissue and parotid gland, and secured with suture. The implants were then placed into the subcutaneous pocket and closed. This was repeated on the left side of the animal, utilizing AlloDerm implants that were prepared in a similar fashion.

Next, two 2-cm midline incisions were made through the skin on the dorsum of the animals, one located anteriorly and the other posteriorly. Subcutaneous pockets were then created by blunt dissection between the panniculus carnosus and the deep fascia investing the dorsal musculature. Three AlloDerm implants measuring 0.5 x 0.5 cm were folded once and then placed into the anterior subcutaneous pocket. Three DermaMatrix implants were similarly prepared and placed into the posterior subcutaneous pocket.

Two animals were sacrificed at each of the 4, 8, and 12 day time points and the implants were recovered, macroscopically inspected, fixed in paraaffin solution, and processed.

RESULTS

At eight days, there was a significant histopathologic difference in fibroblast proliferation between the two implant types in the parotid bed. AlloDerm implants had an average of 20.83 fibroblasts per implant section, compared to 8.33 fibroblasts per implant section in the DermaMatrix (p = 0.0106) [Figure 1]. This difference narrowed after twelve days, when DermaMatrix implants displayed 31.67 fibroblasts per implant, compared to 30.83 fibroblasts per section in AlloDerm implants (p = 0.7330) [Figure 2]. There were no significant differences in the number of inflammatory cells or degree of neovascularization at any time point between AlloDerm and DermaMatrix in the parotid bed.

When comparing the two implants in the dorsum, AlloDerm implants had a higher degree of fibroblast proliferation, 25.83 fibroblasts per section after 12 days, compared to DermaMatrix implants which displayed 15.00 fibroblasts per section (p = 0.0157). AlloDerm implants at 12 days also had a higher number of inflammatory cells per section, 29.17, compared to 16.67 in DermaMatrix implants (p = 0.0066). DermaMatrix implants demonstrated significantly more microvessels, 14.33 per implant, at twelve days compared to only 2.67 microvessels per implant in AlloDerm constructs (p = 0.0459).

When comparing the effects of location for AlloDerm at eight days, there was a higher degree of neovascularization in AlloDerm implants taken from the dorsum (3.5 microvessels per implant section; p = 0.0189), but rats sacrificed at twelve days revealed the opposite, with AlloDerm implants showing a higher degree of neovascularization in the parotid bed (10.5 microvessels per implant section; p = 0.0463) [Figure 3]. There were no statistically significant differences in fibroblast proliferation or inflammatory cells at eight or twelve days in both locations.

DISCUSSION

Fibroblast migration and proliferation have long been known to be an integral part of the wound healing process and our results should be presumed to be a marker for favorable host response with these dermal implants [9]. As such, AlloDerm showed substantial fibroblast proliferation in the parotid bed after eight and twelve days, suggesting good tissue incorporation.

The migration of inflammatory cells is also expected in the course of wound healing and foreign body implantation. Although in sub-significant numbers, DermaMatrix implants in the parotid bed showed higher numbers of inflammatory cells when compared to those in the dorsum, indicating that DermaMatrix may induce a greater host response in the parotid bed by interacting with local salivary tissues.

Neovascularization is also an important part of tissue integration, and the creation of new blood vessels is dependent on a complex interplay between environmental forces and growth factors like VEGF, FGF, and TGF-β [10]. In our study, AlloDerm had a higher degree of neovascularization after twelve days in the parotid bed when compared to DermaMatrix, although the differences were not statistically significant. AlloDerm did show a significant increase in the degree of neovascularization in the parotid bed when compared to implants placed in the dorsum, once again indicating that parotid bed is a favorable site for AlloDerm.

Because AlloDerm and DermaMatrix are proprietary products, very little is publicly known about the reagents and processes used to manufacture them. Elucidating the precise biochemical differences using mass spectroscopy, HPLC, proteomic or analysis to determine physical and chemical differences between the two materials could prove fruitful with additional study.

CONCLUSIONS

In conclusion, our study demonstrates that while there are histological differences between AlloDerm and DermaMatrix, our findings only partially explain our experience with humans who have undergone reconstruction with either material [8]. Additional knowledge about the success of tissue incorporation and the etiology of complications within the parotid bed with these two acellular dermal implants and future studies to better examine their composition could help drive future treatment decisions, in turn producing more successful patient outcomes.

REFERENCES