Use of a Novel Automated Skin Grafting Device to Harvest Full-Thickness Autologous Microcolumns

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INTRODUCTION

Autologous split-thickness skin grafting (STSG) is generally considered the "gold standard" for the treatment of acute and chronic wounds.[1] However, STSG is limited by donor site tissue availability and donor site morbidity including scarring, increased pain and/or infection.[2] Full-thickness autologous microcolumns (FTAM) of tissue have been shown to reduce donor site morbidity.[3]

OBJECTIVE

We evaluated the Autologous Regeneration of Tissue (ART®) System (**Figure 1**); a novel automated skin harvesting device designed to collect full-thickness autologous microcolumns (FTAM) at 0.5mm diameter and depth of 3.25mm for the treatment of full thickness excisional wounds in a porcine model.

METHODS

Eighteen animals were included in a six-week donor and recipient wound healing study. All animals received 12 cm^2 full-thickness excisional wounds that were treated with either FTAM, STSG or Untreated (without graft). Recipient site coverage with donor tissue was 5x greater for STSG treated wounds compared to FTAM treated wounds. The healing trajectories for donor and recipient sites were monitored weekly by clinical observation and biopsies were collected for histologic analyses at terminal timepoints (Weeks 1, 3, and 6 (n=6 per group)). Histological analysis was performed by a pathologist in a blinded fashion.

*ART System®; Medline Industries LP., Northfield, IL
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REFERENCES

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3. Tam J, Wang Y, Farinelli WA, Jiménez-Lozano J, Franco W, Sakamoto FH, et al. Fractional Skin Harvesting: Autologous Skin Grafting without Donor-site Morbidity. Plast Reconstr Surg Glob Open. 2013 Oct 7;1(6):e47

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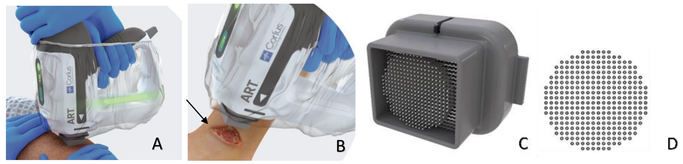

Figure1. ART® Skin Harvesting System A) Harvesting at Donor site and. B) Scatter Procedure at Recipient Site (arrow) with C) Cartridge containing 316 needles with D) Donor Site Collection Area of 6.4 cm^2.

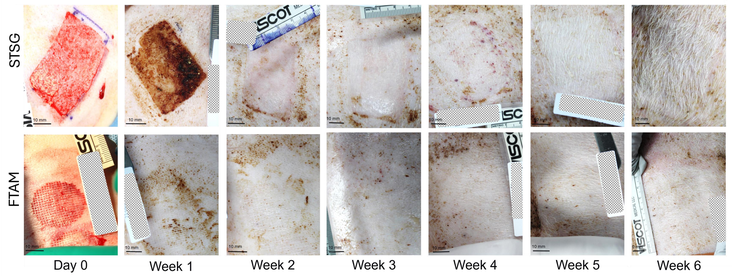

Figure 2. Representative images from Day 0 through Week 6 of STSG (top row) and FTAM (bottom row) donor sites. At week 6, STSG donor skin appearance remains visually distinct from surrounding healthy tissue due to abnormalities in texture and coloration, a cosmetic outcome commonly observed with STSG donor sites in humans.

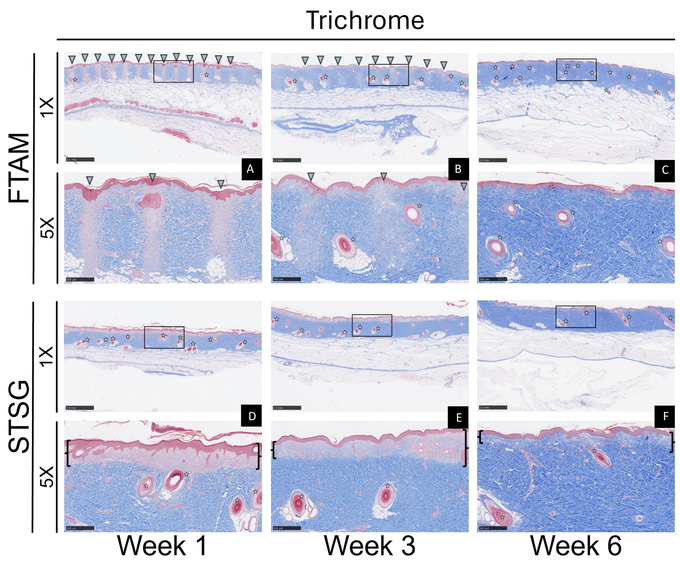

Figure 3. Histological evaluation of collagen at FTAM and STSG donor sites. Representative images of FTAM (A-C) and STSG (D-F) donor site sections stained with Masson's trichrome at 1, 3, and 6-weeks post-harvest. Boxes indicate areas shown at higher (5X) magnification. Collagen appears blue with darker color associated with thicker collagen fibers. FTAM harvest sites (arrowheads) and adnexa (hair follicles and/or glandular tissue) (stars) are indicated. The entire epidermis/top superficial dermal layer is removed during STSG harvest, as shown by pink staining in sections from weeks 1 and 3 (indicated by brackets, 5X magnification, (D-F)). By week 6, STSG donor wounds are not fully healed, as the collagen stain remains light blue (F, bracket).

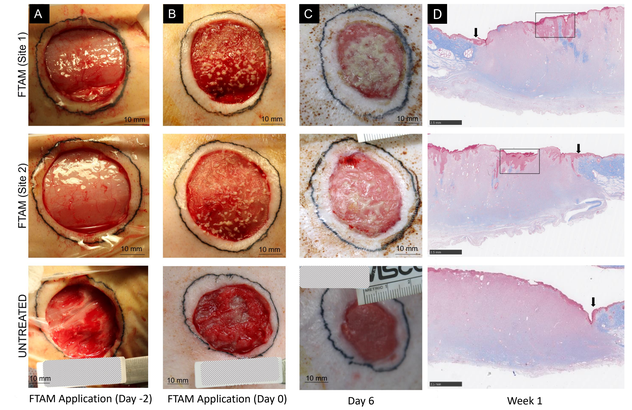

Figure 4. Representative photographs of two recipient sites and one control site two days before (A), immediately following (B), and 6 days post-FTAM deposition (C). Epithelial islands were seen at day 6 as the light-colored substance within FTAM-treated wound beds. Note that epithelial islands may appear like wound sloughing or purulent material, but they consist of epidermal outgrowth derived from the FTAMs. (D) Masson's trichrome staining at 5X magnification. Boxed area shows epithelial islands, arrows indicate wound margins.

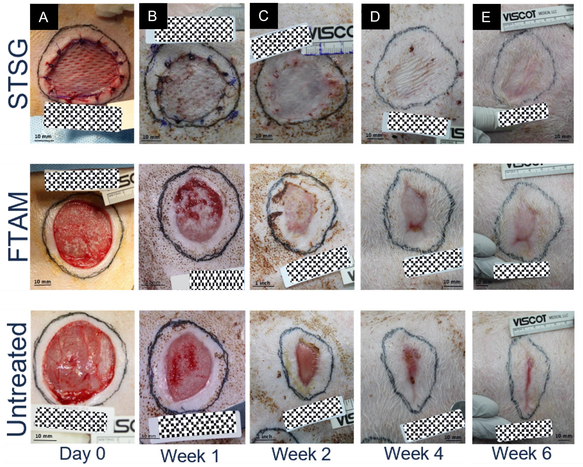

Figure 5. STSG, FTAM, and Untreated recipient sites. Tattoos were used to monitor changes in wound size due to animal growth and assess contracture. Note the presence of a linear scar and incomplete wound closure of Untreated wounds at Week 6. STSG recipient wounds also have the meshed, cobblestone appearance, an undesirable characteristic often observed with STSG in humans.

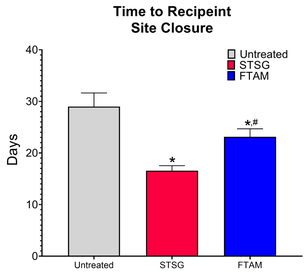

Figure 6. Time to recipient site closure. Data are presented as the mean time to site closure ± SEM. *p<0.05 compared to untreated control, #p<0.05 compared to STSG by One-way ANOVA with Tukey's multiple comparison post-test.

RESULTS

Donor site healing

- *FTAM donor sites heal faster than STSG*.
- STSG had more serocellular crust, erythema, exudate, necrosis, and eschar at early time points and took longer to close. (**Figure 2**)
- At week 6, STSG donor skin remains visually distinct from surrounding healthy tissue. (**Figure 2**)
- FTAM donor sites contained more collagen and adnexal structures and had faster rete ridge restoration compared to the STSG donor sites. (**Figure 3)**

Recipient site healing

- *FTAM and STSG recipient sites heal by re-epithelialization rather than contracture.*
- FTAM recipient sites form "epithelial islands" by day 6 within the wound beds. (**Figure 4)**
- FTAM and STSG sites heal by re-epithelialization whereas untreated sites heal by contracture, and some remained opened at week 6. **(Figure 5)**
- The time to recipient site closure was 4.1 weeks, 2.4 weeks, and 3.3 weeks for Untreated, STSG, and FTAM wounds, respectively. (**Figure 6**)

KEY FINDINGS

- *The ART® System is a minimally invasive skin harvesting device that can be used as an outpatient without the need and expense of a surgical suite*
- *The FTAM donor sites healed at a faster rate with less donor site morbidity than traditional STSG donor sites collected using a dermatome.*
- *The FTAM donor sites showed increased collagen at Week 1, along with adnexal structure and rete ridge formation at Week 3 .*
- *The FTAMs can augment recipient site healing using less donor site tissue because of "epithelial island" expansion that contributes to limited contracture and "meshed pattern" typically seen with STSG healing.*

CONCLUSION

- A novel automated skin harvesting device can be used to collect and dispense FTAM resulting in faster donor site healing and reduced donor site morbidity compared to STSG.
- FTAM and STSG recipient sites had comparable healing rates with less contracture than Untreated sites. FTAM sites had the best cosmetic outcome.