Novel therapy for complete regeneration of functional skin in burn reconstruction: observations of the efficacy and clinical utility of autologous homologous skin construct

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Introduction
Split-thickness skin grafts (STSGs) are the standard of care for large cutaneous defects resulting from burn injuries. Although they provide wound coverage, they lack the dermal appendages and their associated cellular populations needed for regenerating fully functional skin. A novel autologous homologous skin construct (AHSC) created from a small full-thickness harvest was developed to address these limitations. The efficacy of AHSC to reconstruct contractures resulting from split-thickness skin grafts previously used to treat burn wounds was assessed.

Methods
Contracted wounds resulting from STSG in patients (e.g. radial dorsal hand, right lateral neck, left anterior chest, and right hand syndactyly), aged 10-69yo were excised and treated with a single AHSC application. Defect sizes ranged from 25-216 cm². Small full-thickness skin harvests from the patient’s groin, chest or lower abdomen were processed into AHSC, Donor sites were closed primarily. AHSC was returned to the provider 48-72 hours post-harvest per their discretion and applied to the wound-bed. Wound healing was evaluated for 1-4 months with digital photography.

Current Burn Reconstruction Limitations
• STSG works but the results are not aesthetically suitable, STSGs contract, and do not function like normal skin.
• STSG have donor site availability issues and are technically difficult. Results are better than STSG but still not approaching normal.
• Current regenerative adjutants are improving our options. However, new technologies now have the ability to facilitate top tier reconstructive results.

SkinTE Harvest and Application

10 Year Old Male, Burn Scar Keloid Revision

Analysis of Regenerated Tissue of Burn Scar Revision

Scald Burn and STSG Repair

Microscopic and Histological Analysis of Regenerated Skin

Analysis of Regenerated Tissue of Neck Scar Revision Case

Right Hand Syndactyly from Burn Wound

Raman Spectra: AHSC Regenerated Skin vs Native

Summary of Results
All patients' excisional wounds had complete closure and there were no donor-site complications at follow-up. AHSC-treated wounds demonstrated minimal contracture and progressive re-pigmentation. Further evaluation of AHSC-regenerated skin in two of the patients with 3D dermoscopy imaging demonstrated pigmentation, hair follicles, and comparable macroscopic structure to that of native skin. Patients regained full range of motion of neck, arm, and hand, previously limited by STSG contraction.

Conclusions
• AHSC was an effective therapy for burn wound reconstruction and demonstrated regeneration of full-thickness skin with dermal appendages similar to native skin as seen in biopsies of AHSC-treated wounds.
• AHSC is a safe and effective treatment for complex cutaneous wounds including burn reconstruction.
• AHSC can regenerate full thickness skin analogous to native skin, with minimal donor site morbidity.
• Successful outcomes require good patient selection, good technique, wound management and appropriate expectations.
• Larger studies are needed for further evaluation.

Disclosures
Dr. Mundinger and Dr. Granick are clinical advisors of PolarityTE, Inc. All patients have consented to use their photographs in this presentation.

Analysis of Regenerated Tissue of Scar Revision Case

Figure 1. 57 year old female patient had an original skin graft to obtain healing from a severe burn wound. She developed scar contractures which bothered her neck. The scar tissue was revised and treated with AHSC. The healed with regenerated skin which looked normal on histology (Figure 8), although upon gross inspection the healed wound did not look like her normal skin. The scar contracture was markedly improved but not completely resolved. A biopsy of AHSC-regenerated skin was taken for additional analysis (Figure 8).

Figure 2. A 10 year old boy who suffered a large upper torso burn wound treated with STSGs 1.5 years earlier developed painful and functionally limiting skin contractures. The patient, and patient’s guardian elected to excise the affected areas and undergo treatment with an AHSC. Full-thickness skin grafts from the groin was sent to a biotechnological manufacturing facility and processed into AHSC the following day. The AHSC was returned to the provider the following day and applied to a 20% wound area in the left hand. The scar was excised and the AHSC applied to the wound-bed. The AHSC healed over the scar without complication and has no pain. This is an interesting finding since the clinical validation cases were in adults prior to developing serious neonate burn wounds.

Figure 3. Combined hematoxylin and eosin (H&E) stain demonstrates normal dermis and epidermis of AHSC. (a) Regenerated dermis of AHSC shows normal dermal collagen microfibrils and vascular permeability. (b) Regenerated epidermis of AHSC demonstrates normal epidermal thickness and pilosebaceous units. This figure demonstrates that AHSC respected the donor’s unique skin architecture.

Figure 4. AHSC was successfully used in the 10 year old male patient with a full-thickness burn scar on the left hand. AHSC was excised and the AHSC was treated with AHSC. The healed wound did not look like her normal skin. The scar contracture was markedly improved but not completely resolved. The patient regained full range of motion of all fingers and hand post AHSC Therapy.

Figure 5. 1A shows a fracture injury causing a burn scar on the right thoracic wall which was excised and treated with AHSC. The wound healed, but the scar while smaller did not look like her normal skin. The donor site was closed primarily. The AHSC healed over the scar without complication and has no pain. This is an interesting finding since the clinical validation cases were in adults prior to developing serious neonate burn wounds.