3D Bioprinted Skin Accelerates Full-thickness Wound Regeneration

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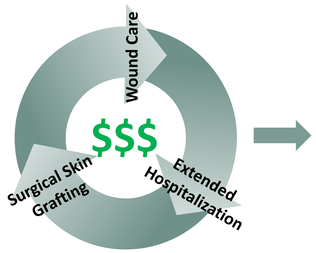
Standard of care for full-thickness wounds

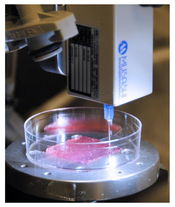


Primary Outcomes
1. Survival

Adverse Outcomes
1. Scarring
2. Contracture
3. No Pigmentation
4. No Hair Growth

Patients treated for full-thickness wounds are often in a repetitive cycle of surgical skin grafting, wound care, and extended hospitalization. This expensive cycle can extend for months to years.

Alternative method to treat full-thickness wounds with bioprinted skin



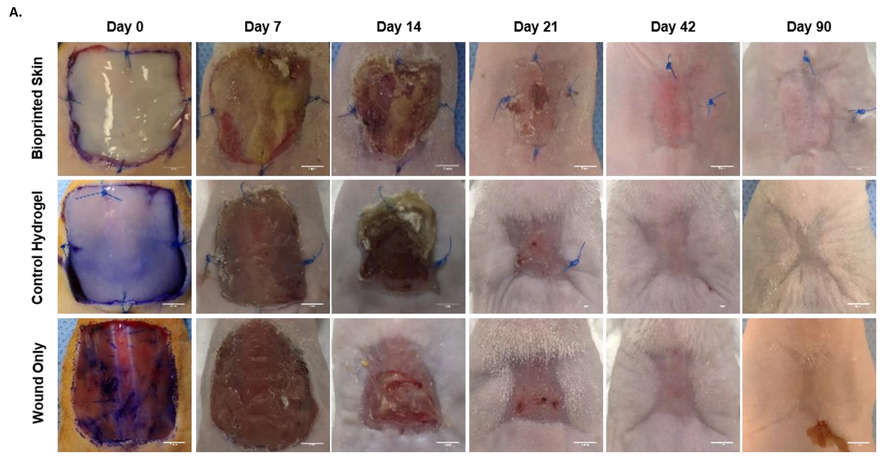
Primary Outcomes
1. Survival
2. Reduced Scarring
3. No Contracture
4. Pigmentation
5. Hair Growth

Alternatively, skin cells could be isolated from the patient during the first surgical grafting procedure. Cells would then be expanded in culture, and bioprinted as tissue engineered skin, allowing for complete wound coverage in one procedure and eliminating the expensive cycle of the current standard of care.

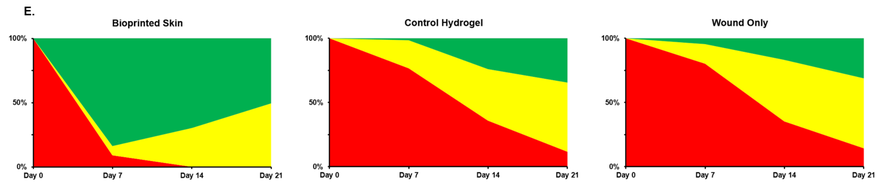
Hypothesis

3D bioprinted skin will accelerate closure of full-thickness wounds, form phenotypically human skin, and reduce contraction and scar formation when treating full-thickness wounds *in vivo.*

Digital images of full-thickness wound closure and hematoxylin and eosin stained samples

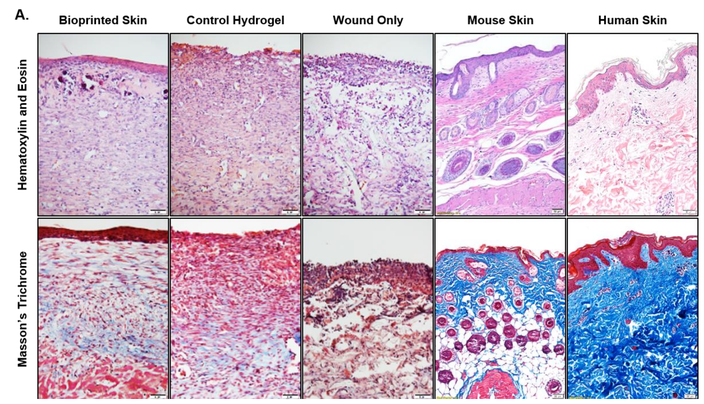


Digital Planimetry for Total Wound Closure, Contraction, and Epithelialization

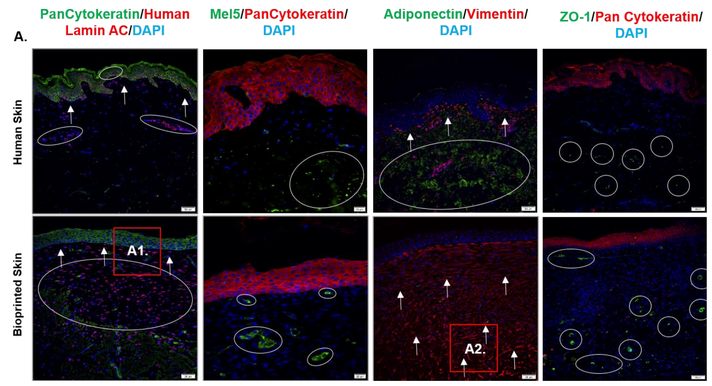


OPEN WOUND - CONTRACTION - EPITHELIALIZATION

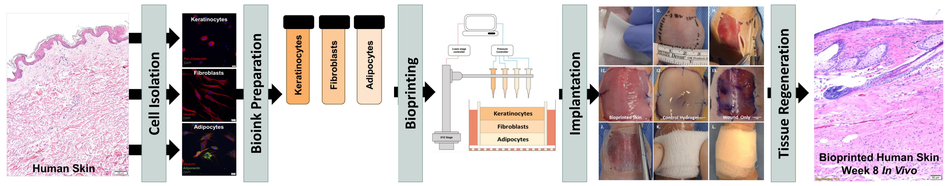
Representative images of chemical stained sample at day 21



Representative images of immunohistochemical stained samples at day 21

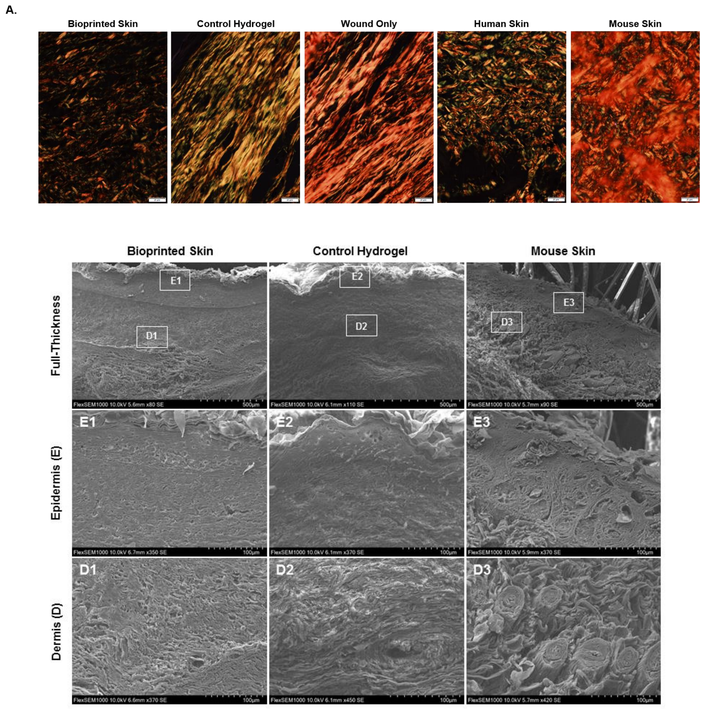


Experimental Design

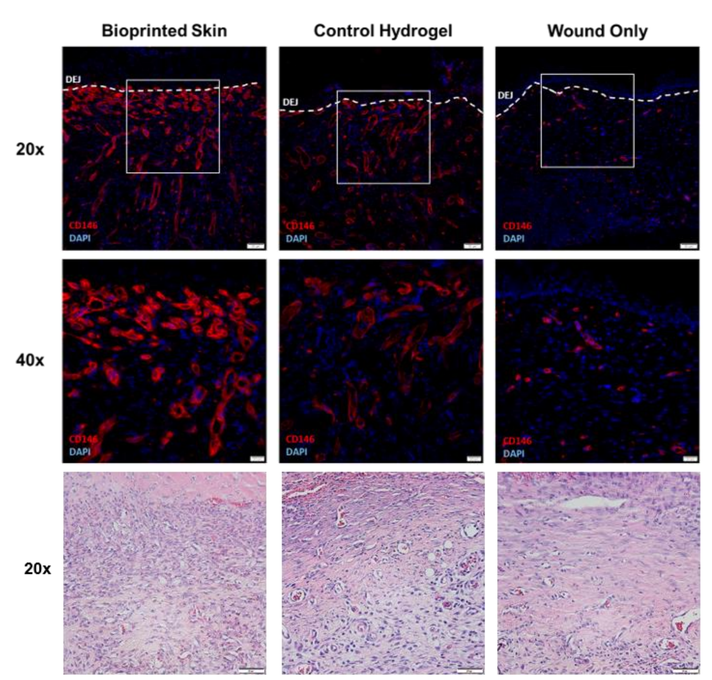


We have replicated our proposed alternative treatment in the lab; isolating cells from human skin, expanding the cells, and bioprinting tri-layer skin structures. The bioprinted skin was then implanted on large full-thickness wounds in mice and allowed to mature over time. Samples were taken at key time-points for histological imaging.

Collagen fiber analysis with Picrosirius Red and SEM



Blood vessel staining to determine revascularization



Conclusions

We have demonstrated that bioprinted skin accelerates total wound closure and epithelialization while reducing contraction over time. The reduced contraction is the result of normal basket weave collagen fiber deposition by fibroblasts in bioprinted skin compared with fibrotic parallel collagen fiber organization in hydrogel only controls. Furthermore, the bioprinted skin formed a phenotypically human epidermis with rete pegs. This technology could eventually provide permanent wound closure for burn patients, restore the skin barrier, and achieve functional and cosmetic results similar to native human skin.

Acknowledgments

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