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REVIEW ARTICLE

Skin bioprinting for burn reconstruction: From stem cell integration to smart *in situ* regenerative systems

Supplementary file

Table S1. Summary of key healing outcomes in mouse models from Table 1 studies on skin bioprinting

Study	% Wound closure (Day 7)	% Wound closure (Day 14)	$CD31^+$ vessel density	Re-epithelialization score	*n*/group	Effect direction (wound closure)	Effect direction (angiogenesis)	Effect direction (re-epithelialization)
Ferroni *et al.*[1]	~58% (Day 10)	~95% (Day 17)	Enhanced angiogenesis evaluated by laminin-immunoreactivity (no quantification); no CD31 staining	Enhanced epidermal thickness; no scoring	5	↑	↑	↑
Hao *et al.*[2]	>85% (Day 7)	~100% (Day 14)	Increased $CD31^+$ IHC, no quantification	Full epidermis + appendages	3	↑	↑	↑
Xu *et al.*[3]	~79.67% (Day 7)	~100% (Day 12)	Increased CD31 fluorescence intensity (~78%)	Length of neo-epithelial tongue (G-S: 22.80 ± 2.02 mm) Area of neo-epithelium (G-S: 32.33 ± 2.79 mm^2) Neo-epidermal thickness (G-S: 147.94 ± 17.37 μm)	3	↑	↑	↑
Fu *et al.*[4]	~50% (Day 7)	~85% (Day 14)	Increased $CD31^+$ capillaries/field: 80 (Day 7) and 50 (Day 14)	Descriptive H&E histology, no score	6	↑	↑	↑
Zhang *et al.*[5]	~84.6% (Day 7)	~99.2% (Day 14)	Increased $CD31^+$ vessels/field: 60.5 ± 6.14 (Day 14)	Descriptive H&E histology, no score	6	↑	↑	↑
Baltazar *et al.*[6]	Not reported	Qualitative descriptions of healing and scabbing	Increased host-derived (mouse $CD31^+$) vessels at day 14 (~14%)	Descriptive H&E histology, no score	3	↑	↑	↑
Apelgren *et al.*[7]	Not reported	Qualitative descriptions of healing; Experimental group 1 (60 days) and group 2 (75 days)	Descriptively observed vascularized fibrous capsule; no CD31 staining	Descriptive H&E histology, no score	Group 1: $n = 10$ Group 2: $n = 11$	↑	↑	↑

Table S1. Summary of key healing outcomes in mouse models from Table 1 studies on skin bioprinting

Study	% Wound closure (Day 7)	% Wound closure (Day 14)	CD31⁺ vessel density	Re-epithelialization score	*n*/group	Effect direction (wound closure)	Effect direction (angiogenesis)	Effect direction (re-epithelialization)
Jorgensen *et al.*[8]	~91.0% (Day 7)	~100% (Day 14)	Descriptively observed vascularization and vessel lumens	Descriptive H&E histology, no score	4	↑	↑	↑
Seol *et al.*[9]	~61% (Day 7)	~72% (Day 14)	Descriptively observed vascular network	Descriptive H&E histology, no score	3	↑	↑	↑
Baltazar *et al.*[10]	Not reported	Not reported; Histological focus, not closure rate	Qualitative perfused CD31⁺ vessels via *Ulex europaeus* agglutinin I staining	Qualitatively described epidermal maturation and rete ridge formation; no score	Not reported	→	↑	↑
Yanez *et al.*[11]	Not reported	Not reported; wound contraction focus, not closure rate	Qualitative observation of microvessels	Thickness epidermal (239 ± 35 μm); epidermal layer regeneration (~90%)	5	→	↑	↑
Michael, *et al.*[12]	Not reported	Qualitative closure was observed (Day 11)	Blood vessels visualized via collagen IV immunostaining; no CD31 staining	Qualitative observation of epidermis formation and integration	3	→	↑	↑

Note: ↑ indicate improvement; ↓ indicate negative effect; and → indicate neutral or non-reported. All results are based on *in vivo* wound healing models. IHC: Effect directions are relative to control groups. From the 15 studies listed in **Table 1**, three lacked full-text access, resulting in 12 studies included in the final analysis.

Abbreviations: H&E, Hematoxylin-eosin; IHC, immunohistochemistry.

Table S2. Summary of key healing outcomes in large animal models from Table 2 studies on skin bioprinting

Study	% Wound closure (Day 7)	% Wound closure (Day 14)	CD31⁺ vessel density	Re-epithelialization score	*n*/group	Effect direction (wound closure)	Effect direction (angiogenesis)	Effect direction (re-epithelialization)
Intini *et al.*[13]	~50% (Day 7)	~100% (Day 14)	Not reported	Qualitative descriptive promotion of epithelialization	12	↑	→	↑
Tanadchangsaeng *et al.*[14]	Not reported	Not reported; wound contraction focus, not closure rate	Increased CD31⁺ vessel density (IHC); no quantification	Qualitative descriptive promotion of epithelialization	9	→	↑	↑
Yang *et al.*[15]	~78% (Day 7)	~94% (Day 14)	Not reported	Epidermis thickness: 37–41 mm; qualitative descriptive promotion of epidermal regeneration and differentiation	3	↑	→	↑

Table S2. Summary of key healing outcomes in large animal models from Table 2 studies on skin bioprinting

Study	% Wound closure (Day 7)	% Wound closure (Day 14)	$CD31^+$ vessel density	Re-epithelialization score	*n*/group	Effect direction (wound closure)	Effect direction (angiogenesis)	Effect direction (re-epithelialization)
Wang *et al.*[16]	~72.2% (Day 8)	~100% (Day 12)	Increased $CD31^+$ vessel/mm^2: 45 (Day 8) and 58 (Day 12); 9.66% $CD31^+$ vessel	Regular epithelial layer starts forming (Day 8); Fully formed epithelium (Day 12)	6	↑	↑	↑
Zhou *et al.*[17]	Rat: ~85% (Day 7)	Rat: ~100% (Day 14); Pig: ~90% (Day 30)	Qualitatively describe increased $CD31^+$ vessel density	Epidermis thickness: Rat: mature epithelium with sebaceous glands and follicles Pig: 77–78 mm	Rat: *n* = 12; Pig: *n* = 3	↑	↑	↑
Shi *et al.*[18]	~90% (Day 7)	~100% (Day 14)	Not reported	Enhanced epidermal regeneration (H&E)	3	↑	→	↑

Note: ↑ indicate improvement; ↓ indicate negative effect; and → indicate neutral or non-reported. All results are based on in vivo wound healing models. Effect directions are relative to control groups. From the eight studies listed in **Table 2**, two lacked full-text access, resulting in six studies being included in the final analysis.

Abbreviations: H&E, hematoxylin-eosin; IHC, immunohistochemistry.

Table S3. Standardized summary of key healing outcomes in mouse models from Table 3 studies on skin bioprinting

Study	% Wound closure (Day 7)	% Wound closure (Day 14)	$CD31^+$ vessel density	Re-epithelialization score	*n*/group	Effect direction (wound closure)	Effect direction (angiogenesis)	Effect direction (Re-epithelialization)
Yuan *et al.*[19]	Not reported	Not reported; the study focuses on sweat gland regeneration, not wound closure	Qualitative $CD31^+$ staining for vessel formation	Not reported	9–15	→	↑	→
Yao *et al.*[20]	Not reported	Not reported; the study focuses on sweat gland regeneration, not wound closure	Not reported	Not reported	3	→	→	→
Huang *et al.*[21]	Not reported; the study focuses on sweat gland regeneration, not wound closure	Qualitative descriptions of wound healing; no quantification	Not reported	Qualitatively describe skin regeneration and epithelial differentiation	5	↑	→	↑
Abaci *et al.*[22]	Not reported	Not reported; the study focuses on hair follicle regeneration, not wound closure	GFP-HUVECs, GS-IB4, RBCs, and lumens confirm vascular integration with the host	Qualitatively describe epithelial coverage, tissue integration, and functional differentiation	10	→	↑	↑

Note: ↑ indicate improvement; ↓ indicate negative effect; and → indicate neutral or non-reported. Effect directions are relative to control groups.

Abbreviations: GFP-HUVECs, green fluorescent protein-labeled human umbilical vein endothelial cells; GS-IB4: *Griffonia simplicifolia* isolectin B4 (commonly used for labeling mouse vascular endothelial cells); RBCs, red blood cells.

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