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Single-step Collagen-elastin Dermal Matrix with Split-thickness Skin Grafting for Keloid Burn Scars: A Case Series

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Single-step Collagen-elastin Dermal Matrix with Split-thickness Skin Grafting for Keloid Burn Scars: A Case Series

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Disclosures

Meredith Elman, MD

Nothing to disclose

Objectives

- Review hypertrophic scarring, keloids
- Treatment modalities
- Discuss dermal substitutes
- Pediatric case presentations
- How to manage future cases?

Keloids and Hypertrophic Scars

- Keloids are a subtype of fibroproliferative disorders caused by aberrant wound healing following trauma, inflammation, surgery, or **burns**
  - Hypertrophic scars stay within the margins of the original wound
  - Keloids are characterized by continuous growth into healthy skin beyond the original wound
- Keloids may pose significant difficulty to affected patients: they can be painful, itchy, impact mobility if they cross joints, and most disruptively, can be physically disfiguring and cause emotional distress

Siotos et al., 2019

Keloid Development Following Burns

- Hypertrophic scars occur in between 30 – 90% of patients following burns
- Risk Factors:
  - Prolonged Healing (aka prolonged inflammation)
  - Using mesh skin grafts with a high expansion ratio (> 1:2)
  - Deep full-thickness burns
  - Burn location
  - Darker skin tone
  - Incurring injury during puberty and pregnancy
  - Genetic predisposition to significant scar formation after injury

Treatment of burn scars

Diagnosis	Therapy			
	First-line	Second-line	Third-line	Management after favorable treatment response
Fresh burn scar (preventive measures)				
	▪ Silicone gel/sheet or onion extract formulations ▪ Begin two weeks after injury (eg, in combination with pressure therapy) ▪ Continue for three months	▪ Pulsed-dye laser (PDL) therapy for persisting erythema		
Immature scar, erythematous hypertrophic scar, minor keloid				
	▪ Triamcinolone acetonide (TAC) injections • Men 20 to 40 mg/mL • Women 10 to 40 mg/mL ▪ Use in combination with silicone gel or sheet ▪ Intralesional corticosteroidal injection with silicone gel or sheeting	▪ Cryotherapy (10 to 15 seconds) ▪ Directly followed by TAC injections until scar has flattened over time	▪ 5- fluorouracil (5-FU; topical) with TAC injections • Administer every other week Or: ▪ Intralesional cryotherapy ▪ Ultimo ratio excision and appropriate prophylactic therapy (NTA)	▪ PDL to reduce erythema
Widespread hypertrophic burn scar				
Tension present	▪ Surgical release • Z-plasty • W-plasty • Excision and reconstructive flaps			
No tension present	▪ Silicone gel preparations ▪ Compression therapy ▪ Onion extract formulations	▪ Individual counseling ▪ Ablative fractional laser		▪ PDL to reduce erythema
Major keloid				
	▪ Cryotherapy (10 to 15 seconds) ▪ Directly followed by TAC injections until scar has flattened	▪ Combination every other week of • 5-FU and • TAC ▪ Intralesional cryotherapy	▪ Combination of • Surgical excision • Radiation therapy • TAC	▪ PDL to reduce erythema

* Fresh burn scar is considered hypertrophic scar.

Adapted with permission from: Gauglitz G. Management of keloids and hypertrophic scars: current and emerging options. Clin Cosmet Investig Dermatol 2013; 6:103. Copyright © 2013 Gerd G Gauglitz, MMS, MD.

Prevention

- Silicone gel sheeting
- Onion extract
- PDL

Diagnosis	Therapy			
	First-line	Second-line	Third-line	Management after favorable treatment response
Fresh burn scar (preventive measures)				
	▪ Silicone gel/sheet or onion extract formulations ▪ Begin two weeks after injury (eg, in combination with pressure therapy) ▪ Continue for three months	▪ Pulsed-dye laser (PDL) therapy for persisting erythema		

Minor Keloid

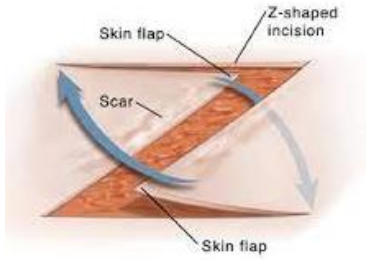
- Steroid injections
- Cryotherapy
- Topical 5-FU

Diagnosis	Therapy			
	First-line	Second-line	Third-line	Management after favorable treatment response
Immature scar, erythematous hypertrophic scar, minor keloid				

	• Triamcinolone acetonide (TAC) injections
	  • Men 20 to 40 mg/mL
	  • Women 10 to 40 mg/mL
	• Use in combination with silicone gel or sheet
	• Intralesional corticosteroidal injection with silicone gel or sheeting
		• Cryotherapy (10 to 15 seconds)
		• Directly followed by TAC injections until scar has flattened over time
			• 5- fluorouracil (5-FU; topical) with TAC injections
			  • Administer every other week
			Or:
			• Intralesional cryotherapy
			• Ultimo ratio excision and appropriate prophylactic therapy (NTA)
				• PDL to reduce erythema

Additional Therapies for More Stubborn Scars

Diagnosis	Therapy			
	First-line	Second-line	Third-line	Management after favorable treatment response
Widespread hypertrophic burn scar				

Tension present	• Surgical release
	  • Z-plasty
	  • W-plasty
	  • Excision and reconstructive flaps
				

No tension present	• Silicone gel preparations • Compression therapy • Onion extract formulations	• Individual counseling • Ablative fractional laser		• PDL to reduce erythema

Treatment of Difficult to Manage Keloids

Diagnosis	Therapy			
	First-line	Second-line	Third-line	Management after favorable treatment response
Major keloid				
	▪ Cryotherapy (10 to 15 seconds) ▪ Directly followed by TAC injections until scar has flattened	▪ Combination every other week of • 5-FU and • TAC ▪ Intralesional cryotherapy	▪ Combination of • Surgical excision • Radiation therapy • TAC	▪ PDL to reduce erythema

Dermal Substitutes

- Single layer durable skin substitutes
- Acellular dermal substitutes may be composed of naturally occurring polymers, e.g., collagen, elastin or hyaluronic acid, synthetic polymers, porcine dermis, or de-epithelialized cadaveric skin
- Advantages:
  - Ease of use, durability
  - Acellular dermal material is non-immunogenic
- Main Disadvantage:
  - Cost

Vecin et al., 2023

Relative Costs of Dermal Substitutes

Composition	Silicon layer overlying a Type I bovine collagen-shark glycosaminoglycan matrix	Acellular dermal matrix made up of Type I, III, and V bovine collagen coated with 3% bovine elastin hydrolysate[8]	Acellular dehydrated sterile dermal matrix donated from cadaveric human skin
Animal/cadaveric source	Bovine, shark	Bovine	Human cadavers
Number of stages required for grafting	1 or 2	1 or 2	1 of 2
Relative cost	$17.96/cm^2	$5.51/cm^2	$32.93/cm^2
Country of production	USA	Germany	USA

Shah et al., 2023

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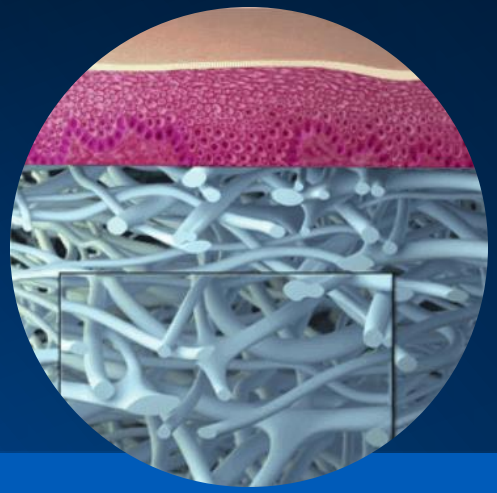
Single-step Collagen-elastin Matrix

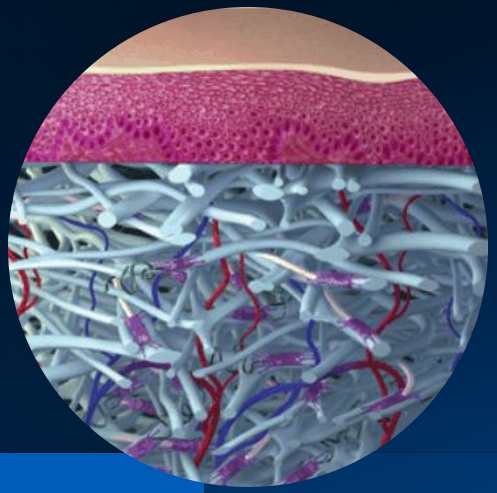
Single-layer Dermal Substitute of Bovine Collagen and Elastin Hydrolysate

- A single-use three-dimensional acellular dermal matrix
- Composed of bovine collagen fibers and bovine elastin
- Porous, three-dimensional acellular dermal matrix composed of Type I, III, and V collagen fibers and elastin, similar to human dermis
- More extensively used in the UK and Europe; received FDA approval for use in the U.S. in 2021

Dickson et al., 2023

Mechanism of Action



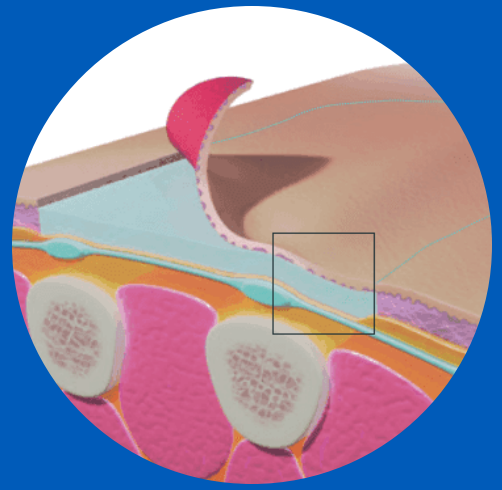


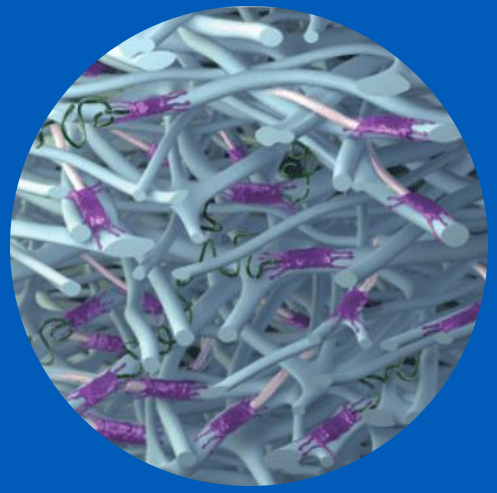
Dermal matrix is applied to wound bed and covered with a secondary dressing (e.g. STSG)

Dermal matrix provides native 3D collagen elastin matrix to facilitate cell migration and guide healing

Fibroblasts are guided by native collagen elastin scaffold ensuring structured healing, neo-dermis formation

Enhanced neo-angiogenesis ensures optimal STSG take





Case Presentation: Patient A

- Right buttock scald burn
- The patient was running through the house, bumped into a table spilling hot soup, then proceeded to slip and fall into the soup
- Originally evaluated at outside hospital

Initial Burn Progression

6 days following injury

10 days

17 days

- Originally managed with daily dressing changes using topical antibiotic ointment, occlusive gauze (bismuth tribromophenate-petrolatum), non-adherent dressing pads, and gauze

Three Months Later: Keloid Development

- Non-excisional interventions:
  - Compression garment (fitted by PT)
  - Silicone sheet dressings
  - Scar massage
  - Carbon dioxide ablative fractional laser (CO_2-AFL) therapy
  - TAC injection

Keloid Excision, Application of Dermal Matrix and STSG, Bolster Application

Dermal Matrix Application Results

. 3 months post-op

14 months post-op

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Case Presentation: Patient B

- Deep and superficial partial thickness burns to perineum and abdomen (4% TBSA)
- Patient was trying to pull hot ramen out of the microwave when it spilled in his lap, resulting in burns to his lower abdomen, genitals, and right thigh

Initial Burn Progression

8 days following injury

1 month

- Originally managed with daily dressing changes using collagenase bacitracin/polymyxin B

Four Months Later: Keloid Development

- Non-excisional interventions utilized:
  - Compression garment
  - PT for range of motion
  - Silicone sheet dressings
  - Scar massage
  - Carbon dioxide ablative fractional laser (CO2-AFL) therapy

7 months

4 months following burn

Surgical Excision

- Seven months post-burn, 3 months post-keloid development: OR for excision of suprapubic keloid scar, application of dermal matrix, split thickness skin graft application to suprapubic wound, negative pressure wound therapy device application

Dermal Matrix Application Results

1 month post-op

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Dermal Matrix Application Results

3 months post-op

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Dermal Matrix Application Results

9 months post-op

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Ongoing Care

- Referral to plastic surgery for consideration of additional interventions (e.g. tissue expanders)
- Appointment scheduled for next month

Conclusion

- Dermal substitutes may be a useful adjunct for difficult to heal keloids
- As a single-step procedure, a dermal substitute has the potential to provide enhanced cosmesis for keloids refractory to existing therapies in the pediatric burn population

Thank you


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What patients should be flagged as potentially high risk for hypertrophic/keloid scar formation?

What therapies should be utilized for keloid formation and in what order?

Moving forward, how would you manage difficult to resolve keloid formation?