Wound Healing – Scar Minimization

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Scar management

“Put sunscreen on it”

“If it feels hard, you can massage it”
Objectives

• Describe the phases of wound healing

• Identify factors which can optimize wound healing

• Understand the goals of scar management

• Describe techniques and products which can aid in scar minimization

• Understand how to apply these techniques and products in the pediatric population
Disclosure

- I have no financial incentive on behalf of any of the products mentioned in this presentation

- All pictures used without permission
Phases of wound healing

1. Inflammatory
   - Hemostatic
   - Cellular

2. Proliferative
   - Reepithelialization
   - Neovascularization
   - Collagen deposition

3. Remodeling/maturation
Phases of wound healing

1. Inflammatory (hemostatic):
   - Convergence of coagulation cascade, complement cascade, and platelet activation
     1. Vasoconstriction $\to$ vasodilation
     2. Platelet degranulation $\to$ TGF-β + others
     3. Platelet plug formation – activated platelets + fibrin + exposed collagen
Phases of wound healing

1. Inflammatory (cellular):

   - Neutrophils – dominant cell type at 1-2 days
     • Phagocytosis of debris and bacteria
   
   - Macrophages – dominant cell type at 2-4 days
     • Regulatory role is essential for wound healing
     • Secrete TNF-α, TNF-β, IGF-1, and IL-1

   - Fibroblasts – dominant cell type at 15 days
     • Myofibroblasts → wound contraction
     • Produce collagen
Phases of wound healing

2. Proliferative (reepithelialization):
   - Collagenase, plasmin, and MMPs begin remodeling wound bed
   - Fibroblasts begin migration from wound edge into wound bed
   - Cellular migration occurs at 12-21 μm/hr
     • Rate is moisture dependent
Phases of wound healing

2 Proliferative (neovascularization):

– Granulation tissue formation – serves as scaffold for cellular migration

– Angiogenesis – via migration of endothelial cells; mediated by VEGF
Phases of wound healing

2 Proliferative (collagen deposition):

- Early formation of type III collagen
- Late formation of type I collagen

- Hydroxylation is *vit. C* dependent
- Tensile strength due to **cross-linking** of collagen fibers
Phases of wound healing

3 Remodeling/maturation:

- Increase in type I collagen deposition

  - Decreased scar dimensions

  - Increased tensile strength

    - 3 weeks – 15% original strength
    - 6 weeks – 60% original strength
    - 6 months – 80% original strength
Optimization of wound healing

- Surgical principles
- Local factors
- Systemic factors
Optimization of wound healing

• Surgical principles:
  – Proper planning of incision
  – Appropriate tissue handling
  – Minimization of wound tension
Optimization of wound healing

• Local factors:
  
  – Desiccation
  
  – Infection

In general, addressed with proper dressing and ABX as indicated
Optimization of wound healing

- Systemic factors:
  - Comorbidities
  - Hypovolemia
  - Malnutrition

In general, addressed with proper medical management, adequate hydration, and nutritional repletion as indicated
Scar management

• Goals:
  – Maintain moisture
  – Minimize tension
  – Avoid inflammation
  – Optimize molecular environment of scar
Sunscreen

• Rationale – to prevent postinflammatory hyperpigmentation

  – Early scars are composed of disorganized tissue, relative to the well defined, layered, composition of adjacent non-wounded skin

  – Therefore UV light can penetrate more deeply into tissue and affect melanogenesis

  – UV light shown to upregulate NO and histamine, which are known stimulators of melanogenesis
Sunscreen

- Efficacy for immature scars is ubiquitously documented

- Evidence is predominately, if not entirely, anecdotal

- Recommendations not established for minimum SPF and duration of treatment
Sunscreen

• “Rubar perseverans”
  – Physiologic, non-inflammatory redness of normal scar
  – Due to vascular elements in the immature scar
  – Typically resolves in 7 months following incisional wounding, but may persist beyond 12 months
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Bond et al. (2008)
Sunscreen

  - SPF $\geq 35$
  - Any time sun exposure is anticipated for $\geq 1$ year
Sunscreen

Unit price: $3.60/oz

http://www.amazon.com
Scar massage

• Rationale – to optimize the molecular environment of scar
  – Mechanical forces induce changes in expression of MMPs and proteases
  – Dissolution of fibrotic tissue which increases scar pliability
  – Release of beta-endorphins resulting in relief of pain
Scar massage

- Ubiquitously advised

- Anecdotally effective

- Recommendations not well established regarding time to treatment onset, technique, frequency, and duration of therapy
Scar massage

• Evidence – Shin and Bordeaux (2012):
  
  – Weak evidence supports use of scar massage in treatment of routine postsurgical scars

  – Study design: systematic review (10 articles, total of 144 patients)

  – Onset:

    • Begin massage after nonabsorbable suture removal (approximately POD#10-14)

    • Avoid massage before POD#10-14
Scar massage

• Evidence – Shin and Bordeaux (2012):
  – Method:
    • Use enough pressure to blanch scar
    • Use nonirritating emollient
    • Massage for 10 minutes BID
  – Not enough evidence to recommend technique or duration of therapy
Scar massage

- Evidence - Bodian (1969):
  - Study design: case series (14 patients with eyelid/periorbital incisions)
  - Technique – rotary movements
  - Duration – 1-2 months

https://handtherapy.wordpress.com
Hydration ointments/dressings

• Rationale – maintain moisture
  – Moist healing promotes rapid epithelialization
  – Retain important molecular messengers within the wound bed
Hydration ointments/dressings

- Ex: mineral oil, petrolatum-based ointments, semi occlusive dressings (Steri-Strip™), occlusive dressings (Tegaderm™)

- Used to speed healing of fresh surgical wounds

- Ointments used over a longer period of time to improve appearance of surgical scars
Hydration ointments/dressings

• Evidence – Winter and Scales (1963):
  – In wounds covered with an occlusive dressing, reepithelialization is 2x as rapid when compared to wounds without a dressing
  – Study design: porcine model
Hydration ointments/dressings

• Evidence – Jackson and Shelton (1999):
  
  – Applying a petrolatum-based ointment to postsurgical scars resulted in a significant reduction of scar erythema between pre- and post-treatment evaluation (endpoint ~1 month)

  – Study design: RCT

  – Onset: day of suture removal

  – Duration: TID x1 month
Hydration ointments/dressings

Unit price: $2.00/oz

http://www.amazon.com
Adhesive microporous hypoallergenic paper tape

• Rationale – maintain moisture, minimize tension, optimize molecular environment of scar

• Use in scar minimization is not common
Adhesive microporous hypoallergenic paper tape

- Evidence – Atkinson et al. (2005):

  - Application of Micropore™ tape to postsurgical scars significantly decreased scar volume and decreased risk of hypertrophic scar formation when compared to untreated scars (endpoint 12 weeks)

  - Study design: RCT (cesarean scars)

  - Onset: after suture removal

  - Duration: 12 weeks (tape changed 2x per week)
Adhesive microporous hypoallergenic paper tape

Unit price: $0.01/in.

http://www.amazon.com
Silicone gel/sheeting

• Rationale – maintain moisture, therapeutic effect of silicone?

• Often recommended to patients for treatment of existing keloids and hypertrophic scars
  – Mixed evidence exists to support this recommendation

• Not often mentioned for prophylaxis of postsurgical scars
  – Relatively well studied
Silicone gel/sheeting

• Evidence - Signorini and Clementoni (2007):
  – Silicone gel application to postsurgical scars resulted in significant improvement in scar appearance when compared to untreated scars (endpoint 6 months)
  – Study design: RCT
  – Onset: POD#10-21
  – Duration: BID x4 months
Silicone gel/sheeting

- Evidence - Chan et al. (2005):
  - Silicone gel application to postsurgical scars demonstrated significant improvement in pigmentation, vascularity, pliability, and height when compared to scars treated with a water-based gel (endpoint 3 months)
  - Study design: double-blinded RCT
  - Onset: POD#14
  - Duration: BID x3 months
Silicone gel/sheeting

- Evidence - Gold et al. (2001):
  - Silicone sheet application to postsurgical scars resulted in a significant decrease in abnormal scar formation, in high-risk patients, when compared to untreated scars (endpoint 6 months)
  - Study design: RCT
  - Onset: POD#2
  - Duration: ≥ 12 hrs/d x 6 months
Silicone gel/sheeting

• Evidence - Niessen et al. (1998):
  – Neither silicone gel nor silicone sheets demonstrated significant improvement in height/width/color of postsurgical scars when compared to scars treated with Micropore™ tape (endpoint 12 months)
  – Study design: RCT
  – Onset: POD#3
  – Duration: 24 hrs/d x3 months
Silicone gel/sheeting

Unit price: $0.71/sq. in.

http://www.amazon.com

Unit price: $90.00/oz

http://www.amazon.com
Moist exposed burn ointment (MEBO)

• Rationale – maintain moisture, therapeutic effect of plant extracts?

• Patented in 1995 in USA

• 6 herbal extracts in a base of beeswax and sesame oil

• Active ingredient – β-sitosterol

• Characteristics – strong smell

• Side effects: acne exacerbation
Moist exposed burn ointment (MEBO)

- Evidence - Atiyeh et al. (2003):
  - STSG donor sites treated with MEBO demonstrated significantly faster reepithelialization and better scar quality when compared to treatment with a Tegaderm dressing (endpoint 6 months)
  - Study design: RCT
  - Onset: POD#0
  - Duration: daily application until reepithelialization occurred
Moist exposed burn ointment (MEBO)

• Evidence - Atiyeh et al. (2003):
  – Postsurgical facial incisions treated with MEBO demonstrated cosmetically better scars when compared to incisions with no treatment or those treated with ABX ointment (endpoint 6 months)
  – Study design: controlled trial
  – Onset: POD#0 or after steri-strip removal
  – Duration: TID-QID x6 weeks
Moist exposed burn ointment (MEBO)

Unit price: $21.00/oz

http://www.amazon.com
Pressure dressing

• Rationale – to optimize the molecular environment of scar
  – Compression induces apoptosis and modulates cytokine expression to prevent scar hypertrophy

• Ubiquitous use in management of hypertrophic scars and burn scars
  – Anecdotally effective
Pressure dressing

• Evidence – Russell et al. (2001):

  – Zimmer splints, along with a single corticosteroid injection, resulted in ≥50% reduction in keloid size in each patient studied (endpoint 12 months)

  – Study design: case series

  – Onset: not stated; patients with keloids following ear piercing

  – Duration: ≥12 hrs/d x6 months
Pressure dressing

• Evidence:

  – No evidence to support the use of pressure dressings to improve the appearance of keloids in other parts of the body

  – No evidence to support the use of pressure dressings to improve the appearance of normal postsurgical scars

http://www.colonialmedical.com
Vitamin E

• Rationale – antioxidant properties reduce the amount of reactive oxygen species during the inflammatory phase of wound healing

• Topical α-tocopherol in an oil base

• Role as an antioxidant is well studied in-vitro

• Anecdotally effective to speed wound healing and improve scar appearance
Vitamin E

• Evidence - Baumann and Spencer (1999):
  
  – Topical Vitamin E application did not demonstrate a significant difference in the cosmetic appearance of postsurgical scars when compared to scars treated with a petrolatum-based ointment (endpoint 12 weeks)

  – Topical Vitamin E application resulted in an increased incidence of contact dermatitis when compared to application of a petrolatum-based ointment
Vitamin E

- Evidence - Baumann and Spencer (1999):
  - Study design: double-blinded RCT
  - Onset: POD#0
  - Duration: BID x4 weeks
Vitamin E

Unit price: $5.50/oz

http://www.amazon.com
Vitamin D

• Rationale – decrease the risk of hypertrophic scars due to its role as an anti-inflammatory molecule and its ability to decrease keratinocyte proliferation

• Calcipotriol (synthetic Vitamin D derivative)
  – Currently used in topical treatment of psoriasis
Vitamin D

• Evidence - van der Veer et al. (2009):
  – Application of topical calcipotriol to postsurgical scars demonstrated no significant difference in the prevalence of hypertrophic scars, when compared to placebo treated scars (endpoint 12 months)
  – Study design: double-blinded RCT (did not study scar appearance or content of placebo ointment)
  – Onset: POD#10
  – Duration: BID x3 months
Vitamin D

http://www.ioffer.com

Unit price: $50.00/oz

http://www.amazon.com

Unit price: $5.00/oz
Mederma®

• Rationale – the anti-inflammatory properties of Quercetin could improve raised, erythematous, or otherwise symptomatic scars

• Very popular OTC product aimed at scar minimization

• Active ingredient – allium cepa (onion extract)
  – Derivative is Quercetin
Mederma®

- Evidence - Jackson and Shelton (1999):
  - Application of Mederma® to postsurgical scars demonstrated no significant difference between pre- and post-treatment evaluation of scar erythema
  - Study design: RCT
  - Onset: day of suture removal
  - Duration: TID x1 month
Mederma®

- Evidence - Chung et al. (2006):
  - Application of Mederma® to postsurgical scars demonstrated no significant difference in scar appearance or symptomatology, when compared to treatment with petrolatum-based ointment (endpoint 12 weeks)
  - Study design: double-blinded RCT
  - Onset – day of suture removal
  - Duration – TID x8 weeks
Mederma®

Unit price: $29.00/oz

http://www.amazon.com
Product summary

• Remember fundamentals:
  
  – Maintain moisture and decrease tension
  
  – Reasonable to use Steri-Strips™ at time of wound closure
  
  – Reasonable to begin topical therapy after sloughing of Steri-Strips™ or removal of nonabsorbable sutures
  
  – Reasonable to continue topical therapy 6-12 months
Product summary

- Sunscreen – Overwhelming opinion recommends use in treatment of routine postoperative scars
  - SPF $\geq 35$ for $\geq 1$ year

- Scar massage – Weak evidence to support use in treatment of routine postoperative scars
  - 10 min BID x1-2 months

- Hydration (petrolatum-based) ointment – Evidence supports use in treatment of routine postoperative scars
  - TID x1 month
Product summary

• Micropore™ tape – Evidence supports use in treatment of routine postoperative scars
  – continuous x12 weeks; change 2x per week

• Silicone gel – Mixed evidence supports use in treatment of routine postoperative scars
  – BID x3-4 months

• Silicone sheets – Mixed evidence supports use in treatment of routine postoperative scars
  – ≥ 12 hrs/d x3-6 months

• MEBO – Evidence supports use in treatment of routine postoperative scars
  – TID-QID x6 weeks
Product summary

- Pressure dressing – no evidence to support use in treatment of routine postsurgical scars
- Vitamin E – no evidence to support use in treatment of routine postoperative scars; some authors discourage use in treatment of routine postoperative scars
- Vitamin D – no evidence to support use in treatment of routine postoperative scars
- Mederma® – no evidence to support use in treatment of routine postoperative scars
Pediatric pearls

• Infants have immature epidermal-dermal bond

• Protect epidermis with proper dressing:
  – Opt for ointment rather than adhesive dressing
  – If using adhesive dressing, opt for latex-free hypoallergenic paper tape (Micropore™) to decrease skin trauma
  – Foam dressings (Mepilex®) are more absorptive than plain gauze, allowing for decreased frequency of dressing changes
Pediatric pearls

• Prevent pain:
  – In infants, consider distraction technique or oral sucrose administration during dressing changes
  – In children, always pre-medicate with analgesics before dressing changes
  – For painful wounds or difficult locations, consider anxiolytic administration along with analgesics before dressing changes
Thank you!
Scar management

“Put sunscreen on it”

“If it feels hard, you can massage it”
References

References

References


