Wound Care for OTs and PTs

Wound Care for OTs and PTs: Learning Objectives
1. Describe the normal anatomy and physiology of the skin and subcutaneous tissue
2. Describe the sequence of normal wound healing and altered states that delay it
3. Document wound assessment
4. Describe mechanical and chemical treatments to aid wound healing and scar remodeling
5. Describe specific care procedures for clean surgical incisions, open wounds, thermal injuries

Wound Care for OTs and PTs: Tips

Your Questions for the Discussion Sessions
Write them on notecards as you think of them

Practical Matters
Can everybody see? Hear?
Room temperature?
Cell phones, beepers
Auditorium’s policy on food/beverage
Restrooms
Evaluation forms and certificates
Ready, set, go……

Wound Care for OTs and PTs

History of wound care
Skin anatomy/physiology
Normal wound healing
Altered wound healing
Sterile technique
Wound assessment

Dressings
Treatments
Scar modeling
Clean surgical incisions
Open wounds
Burns, Frostbite

Ancient History

- Egypt >1600 BCE: described >48 wound types
  Dress wounds with honey/lint/grease
- India, 1000 BCE
  Remove blood clots, stones, hair, nails, bone followed by thorough cleansing
  >100 plants to aid wound healing
  Types of suture: straight, interrupted, subcuticular
- Hippocrates, Greece, 500 BCE
  Irrigate wounds w/ vinegar, ulcers w/ wine (fig leaf dressings)
  Pus: unnatural, to be avoided

History of Wound Care

Pedro K. Beredjiklian MD
Professor, Orthopaedic Surgery
Sidney Kimmel Medical College, Jefferson
Chief, Division of Hand Surgery
Rothman Institute
Ancient History

- Celsus (2nd Century AD)
- “rubor, calor, dolor, tumor”
- (redness, heat, pain, swelling)
- Defined inflammation

Galen

- 2nd Century
- Writings prevailed as dogma for >1000 years
- “laudable pus”

Theodoric Borgognoni

- Dominican friar, personal physician to the Pope
- Ideal conditions for wound healing
- Control of bleeding
- Removal of contaminated or necrotic material
- Avoidance of dead space
- Careful application of the wound dressing
- “Avoid laudable pus”
- Was denounced by both religious and medical colleagues, remained so until mid 19th C

Ambrose Pare

- Father of Surgery
- Tied off bleeding vessels instead of searing
- Observed that maggots cleaned wounds

Ignaz Semmelweis

- Wash hands between cadaver lab and ward patients
- Mortality drop: 10-35% to <1%
- No scientific explanation
- Ridiculed by peers
- Went insane

Louis Pasteur

- Advocates of Germ Theory
- 1822 - 1895
- Robert Koch
Joseph Lister

- Carbolic acid
- Sprayed on instruments, skin, dressings (anti-sepsis)
- 1865: open femur fracture healed without suppuration

Florence Nightingale

- Believed diseases and epidemics were caused entirely by environmental influences
- Devoted to hygiene and sanitation in hospitals.
- Regular linen changing, adequate ventilation, scrubbing of floors and walls.

Future

- Role of expert tissue viability practitioners
- Emergence of negative pressure wound therapy
- Engineered tissue
- Skin Substitutes
- Growth Factors
- Genetic Engineering

Skin Anatomy & Physiology

Kevin Lutsky, MD
Hand, Upper Extremity and Microvascular Surgery
Associate Professor, Orthopaedic Surgery, TJU

Outline

- Skin functions
  - not just a barrier
- Skin anatomy
  - two “types”
- Skin physiology
  - key systems
- Nail anatomy/physiology

Thank You!
**Skin Function**

- Protection
  - Fluids/toxins
- Water regulation
- Microbes
- UV light
- Temperature control
- Sensation
- Vitamin D regulation
- Social/Identification

**Skin Anatomy**

- epidermis
- dermis
- fat
- sensory organs
- nerve
- artery
- sweat gland
- dead cells
- sweat duct

**Skin Anatomy**

- Glabrous vs. Hair bearing
- thicker epidermis
- ↑ capillary beds
- ↑ sensory units
- arrector pili muscle
- sebaceous glands
- apocrine glands

**Skin Physiology**

- Barrier function
  - Epidermis relatively impervious
    - Lattice network of cells + lipid rich matrix
    - Keeps “out” water, sodium, potassium
    - Also important to keep water IN
  - Palm is least permeable skin in body

- Palm: least permeable
  - Dorsum of hand: most permeable

- Temperature Control
  - skin can harbor up to 1/4 of circulating blood volume (more than the brain!)
  - arteriovenous plexus regulation
    - From 1/10 teaspoon to 1/3 cup in the palm per minute

**Skin Physiology**

- 2.5 million sweat glands
  - Eccrine glands = temp control
  - Hair follicle:
    - Apocrine glands = scent/pheromones
    - Sebaceous glands = waterproof/moisturize
- Skin largest water storage site
  - 1/3 of body fluid
Skin Physiology

• UV Protection/Pigmentation
  – epidermal layer reflects some UV radiation
  – UV stimulates melanocyte activity → melanin
  – conversion of cholesterol to Vit D3

Skin Physiology

• Immune Response
  – Mast cells and macrophages
    • Waiting/ready to neutralize foreign invaders
  – Langerhans cells
    • Recognizes foreign invaders & presents them to T-cells

Skin Physiology

• Sensation
  – Exceptional density of nerve endings & sensory organs can detect:
    • weight of 0.005g
      – 1 mosquito
    • temperature 0-111°F
    • send signals 2-120m/s
      – Up to 275mph!

Skin Sensory Organs

• Sensory Homonculus
  – Meissner corpuscles
  – Merkel cells
  – Pacinian corpuscle
  – Ruffini corpuscle

Skin Sensory Organs

Nail Function

• Protection
• Sensory perception
• Assist motor function
• Stabilize pulp for forceful pinch

Nail Anatomy

• Paronychium
• Eponychium
• Lunula
• Germinal Matrix
• Sterile Matrix
• Extensor Tendon
Nail Physiology

- Grows about ~3mm per month
  - Full nail regrowth up to 6 months
  - Transverse (Beau) lines akin to growth rings
- Occur with changes in health, circulation

Citations

- Color Atlas of Dermatology; Rocken, M; Schaller, M; Thieme Medical Publishers, 1st Ed
- Fitzpatrick's Dermatology in General Medicine; Lowell G, Stephen K; McGraw Hill, 8th Ed
- “Basic physiology of the skin” Venus M, Waterman J; Surgery 29:10, 2011
- “Structure and function of hair, nails, and skin” Lai-Cheong J, McGrath J; Surgery 37:5, 2009

Normal Wound Healing

Michael Rivlin, M.D.
Hand and Upper Extremity Surgery
Rothman Institute
Thomas Jefferson University

Wound Healing

A well-organized and orderly cascade of events that occurs following tissue damage to restore the integrity of the tissue

So what is tissue?

Independently functioning cells

“Let’s join together!”
"ground substance" (principally hyaluronic acid) serves as water reservoir and facilitates even diffusion of nutrients through extracellular space.

Tissue!

All was well, until....
Bleeding from capillaries
Release of toxic intracellular fluid
Breakdown of communication

Fibrin meshwork
Platelet plug
Dilated capillary
Extracellular fluid
Chemical messengers (histamine, growth factors, etc.)

Fibroblast
White cell
Collagen
Capillary buds
Old blood

Collagen + capillaries = granulation tissue

Before

Wound Healing

After
Phases of Wound Healing

I. Hemostasis
Within seconds: coagulation cascade activated
forms fibrin meshwork of clot → scaffold for later repair
generates vasoactive and chemotactic factors, attract WBC’s

II. Inflammation
Within minutes: platelets adhere to injured vessels to stop bleeding
Platelets degranulate
Vasoactive amines (seratonin)
Growth and chemotactic factors (PDGF, TGF-β, IGF)

III. Fibroplasia
(proliferation)

Wound Healing I: hemostasis

• Minutes to days
• Vessels dilate → WBC’s, plasma, proteins leak out
• Neutrophils (24 hrs)
  – Phagocytize bacteria
  – Release lysosomal enzymes to degrade necrotic tissue
  – Ingest and remove dead material
• Clinical: redness, swelling, warmth, pain

Wound Healing II: inflammation

• Central to wound healing
• Functions
  – Ingest bacteria
  – Proteases degrade dead/foreign material
  – Secretes cytokines to recruit and activate fibroblasts and endothelial cells
  – PDGF, TGF-β, VEGF → stimulate fibroplasia, collagen synthesis, and angiogenesis
• Orchestrates transition from inflammation to tissue repair

Wound Healing IIIa: early fibroplasia

• Day 2 to several weeks
• Granulation tissue: capillaries, fibroblasts, loose collagen, macrophages
• Fibroblasts migrate into the wound on the fibrin strands, proliferate, produce collagen ~ day 4
• Angiogenesis: new capillary formation

Wound Healing IIIb: late fibroplasia

• Weeks 4-5, fibroblasts decrease in number, collagen synthesis decreases
• Randomly oriented collagen fibers fill and support the wound
• Wound contraction: fibroblast mobility pulls attached collagen fibrils closer together
• +/- role of smooth-muscle-like myofibroblasts
Wound healing IV: maturation

- 3 weeks to 2 years
- Fibroblast population decreases
- New capillaries regress & disappear
- Swelling subsides (decreased extracellular water)
- Wound strength increases
  - Collagen synthesis = degradation
  - Collagen more organized, stronger (cross-links)
  - Type III collagen (embryonic) is replaced with Type I

Phases of Wound Healing

- I. hemostasis
- II. inflammatory
- III. fibroplasia
- IV. maturation

Primary vs. Secondary Wound Healing

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<tr>
<th>Feature</th>
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<td>Outcome</td>
<td>Contracted Irregular Linear Scar</td>
<td>Linear Scar</td>
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Example of Primary Wound Healing

immediately after surgery, no inflammation
Example of 2º Wound Healing

A. pre-op

Dupuytren Contracture >>>> Moderate at MCP
Severe at PIP

B. 3 months post-op

At surgery
McCash Open
Palm Technique

A. 10 Weeks
B. 5 Weeks
C. 2 Weeks

Different Hands

A. 10 Weeks
B. 3 Months
C. 12 Months
D. 48 months

Example of 2º Wound Healing

A. pre-op

Dupuytren Contracture

B. 2 days post-op

0 Days
2 Days
16 Days
21 Days
28 Days
44 Days
65 Days
84 Days

0 Days
28 Days
44 Days
65 Days
84 Days
Primary closure and healing

Healing by Secondary Intention

- Granulation/contraction

Saw, near amp, wounds closed by secondary intension

Courtesy A. Navarrete

Healing by Secondary Intention

- Drug abscess, immediate s/p I & D, 1 wk later
- Granulation/contraction

s/p finger felon I & D, healing by secondary contracture
Autodebridement, granulation, contraction and epithelialization: acute, 2 wks, 6 wks, 8 wks, 17 wks

Split Thickness Skin Graft (STSG)
- Epidermis and varying degrees of dermis
- No need for donor site closure
- Larger defects
- Secondary contraction

Full Thickness Skin Graft (FTSG)
- Entire epidermis and dermis
- Donor site must be closed
- Used to cover smaller defects
- Better color consistency, texture
- Less secondary contraction

FLAP COVERAGE when
- primary closure is impossible
- secondary intention would take forever and limit function
- injury is not amenable to skin grafting

FLAP FEATURES
- Donor location: Local vs regional vs distant
- Blood supply:
  - Random (capillaries only)
  - Axial (robust arterial supply)
    - Pedicle (artery not divided)
    - Free (artery divided and transferred)
- some
Regional Flap

- Cross finger
- Thenar

Distant random pedicle flap
- groin

Regional axial pedicle flap
- Radial forearm flap
  - melanoma

Distant axial pedicle flap
- groin

Distant axial free flap
- Rectus abdominus, stsg

THE END
Altered Wound Healing

Kevin Lutsky MD
Hand, Upper Extremity and Microvascular Surgery
Associate Professor, Orthopaedic Surgery, TJU

Three Phases of Wound Healing

- **Homeostasis**
- **Inflammatory Phase**
  - Cytokines, growth factors, neutrophils, macrophages
- **Proliferative Phase**
  - Begins when wound is covered by epithelium
  - Production of collagen is hallmark
- **Remodeling Phase** (Maturation Phase)

Cessation of the normal healing process occurs in the inflammatory phase

Impaired Healing

- **persistent inflammation**
  - acute to chronic
- **molecular changes**
  - cytokines
  - growth factors
  - extracellular matrix
- **cellular changes**

Cellular Changes

- **Neutrophils**
  - Help clean wound
  - Usually gone after 72hrs
  - Persistent in chronic wounds -> inflammation
- **Macrophages**
  - Release chemical factors
  - Release proteinases
  - Intracellular signaling using Cyclic-Adenosine Monophosphate (C-amp)
  - Affected by NSAIDS, Steroids
  - Remove neutrophils
    - Impaired in diabetes

Molecular Changes

- **Extracellular matrix**
  - Increase in degradative proteinases
  - Reduction in tissue inhibitors of proteinases
  - Imbalance between degradative versus protective enzymes

Stimulates the macrophage
Release inflammatory cytokines
Suppresses collagen synthesis
Growth Factor Concentrations Reduced
- Cells not as responsive (senescence)

Cytokines
- Inflammatory cytokines predominate
- Reduced concentration of factors that promote proliferation

Factors Affecting Wound Healing
- Age and gender
- Sex hormones
- Stress
- Ischemia
- Diseases: diabetes, keloids, fibrosis, hereditary healing disorders, jaundice, uremia
- Obesity
- Medications: glucocorticoid steroids, non-steroidal anti-inflammatory drugs, chemotherapy
- Alcoholism and smoking
- Decreased immunity: cancer, radiation therapy, AIDS
- Nutrition

Must address patient-related factors prior to focusing on the wound!
- Optimize the patient
  - Circulatory
  - Pulmonary
  - Nutrition
  - Associated diseases or conditions
  - Adjust medication

Oxygen
- Initial hypoxia needed stimulate nl healing process
- Most common cause of wound infection
- Large vessel disease
  - atherosclerosis, diabetes, hypertension, peripheral arterial disease, thrombus, embolus
- Microvascular disease
  - Diabetic and hypertensive microangiopathy, thromboangiitis obliterans, Raynaud disorder

Hyperbaric Oxygen (HBO)
- Must have evidence of hypoxia otherwise not shown to be helpful
- Must have some arterial flow
- No effect on necrotic tissue

Chronic draining sinus s/p ORIF comminuted proximal ulna fracture in a heavy smoker

NEEDS BLOOD SUPPLY!!
TREATMENT: Debridement and FCU flap
HBO

100% O₂, 3-5x/wk, 2-2.5 ATM, 1-2 hrs
• 4x increase in the oxygen diffusion at arterioles
• 2x increase at the venules
• Beneficial effects in animal models
  – Reduction of tissue edema
  – Improved wound healing
  – Increased angiogenesis
  – Increased fibroblast proliferation and collagen synthesis
  – Antibacterial properties

Scleroderma

previous amputations from severe ischemia
patient sick and refused sympathectomy
first botox injection: tip healed
second botox injection: ulcer healed

Diabetes

• Affects healing in many ways, including
  – Impaired sensation -> repetitive trauma, pressure
  – Impaired large and small vessel flow

Nutrition

– Inadequate protein and nutrient intake
– Extreme body mass index (BMI)
– Limited mobility
– Hypoalbuminemia
– Impairs all stages of wound healing

Infection

• Contamination -> colonization -> local infection -> spreading invasive infection
• Degradation of growth factors, cytokines, metalloproteases
• Reduced oxygen
• Prolonged inflammation
• Polymicrobial: critical colonization leads to infection. Symbiotic

HBO

• Kranke and Bennet 2015 Cochrane database
  – Beneficial in first 6 weeks
  – No difference long term
  – No change in minor amputation rate
  – May help reduce major amputation rate
• Effectiveness shown by accumulating clinical experience (mostly uncontrolled)
• Indications approved and recognized by professional organizations and third-party payers
• Good safety record
Smoking
Nicotine -> vasoconstriction -> limits perfusion
• 1 cigarette = vasoconstriction > 90 min
Carbon monoxide competes with oxygen
Multiple effects at cellular and molecular level
Results include
• Decreased immunity and bone mineral density
• Increased risk perioperative complications, fracture, tendon injury
Brief perioperative cessation may mitigate these risks

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Drugs
• Steroids
  – Arrest of inflammation response
  – Inhibit macrophages and neutrophils
  – Interfere with granulation and wound contraction
• Chemotherapeutic agents
  – Adriamycin
  – Tamoxifen
  – Angiogenesis inhibitors
  – Methotrexate

steroid-induced wound dehiscence treated with bilobed flap and stsg
Courtesy Phil Plazar

OBESITY
Direct adverse effects on wound healing
• decreased vascularity in adipose tissue
• skin folds harbor bacteria
• friction caused by skin on skin
• increased wound tension
• increased tissue pressure
• hematoma and seroma formation

Indirect effects
coronary disease, atherosclerosis, stroke, hypertension,
diabetes, cancer, dyslipidemia, respiratory problems

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Age
• Increased inflammation
• Delayed epithelialization and matrix production
• Systemic and local factors more important than age itself

Age
• Increased inflammation
• Delayed epithelialization and matrix production
• Systemic and local factors more important than age itself

Edema
• Too much of a good thing!
  – Moisture needed for epithelialization
• Extracellular water increases diffusion distances, resulting tissue hypoxia.
• Chronic edema
  – protein deposition in the extracellular space
  – diffusion barrier for growth factors & nutrients,
  – growth factors and nutrients are relatively diluted in the edema fluid

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One More Cause of Altered Wound Healing
“This never heals. I’ve heard wonderful things about you. I hope you can help me.”

One More Cause of Altered Wound Healing
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Hand surgery or therapy can’t heal these patients

Hand surgery or therapy can’t heal these patients
References


Introduction

• Techniques to minimize contamination of treatment environment
  • To prevent surgical site infections (SSI)
    • delay wound healing
    • increase antibiotics use
    • Increase hospital stay
    • Increase costs of health care (Medicare does not reimburse for SSIs)
  • To protect health care professionals

Percent Positive Bacterial Cultures

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Normal Skin Flora

1 trillion/person, mainly superficial epidermis hair follicles
Species vary by body area
Many harmless or beneficial

Pathogen Transmission

• Bacterial Transmission
  • Alcohol based sanitizer (at least >60% alcohol)
  • Enough so it takes 20 secs to dry
  • Medicated soap
  • Water alone
  • Unmedicated soap - worst
• Viral Transmission via Hands
  • 90% alcohol sanitizers: effective against flu, cold, HIV
Gloves

- To protect you: exam gloves
- To protect wound: sterile gloves
- Double gloving
  - Significantly more protection
- Gloves too large
  - No tactile feedback
  - Diminished pinch
  - Puncture more likely

Hand drying

A study from the University of Westminster revealed that jet hand dryers spread bacteria 1,300 times more than average paper towels. To determine which disperses more viruses and bacteria, researchers compared three modes of hand drying - paper towels, a warm air dryer and a jet air dryer. Apr 18, 2016

Occupational Safety and Health Administration - Waste

Liquid or semi-liquid blood or other potentially infectious material (OPIM)

Items caked with dried blood or OPIM capable of releasing these materials during handling

Contaminated sharps

Cleaning up

Wear gloves, consider eye protection
1:10 dilution bleach, or bleach wipes
Clean once
Clean again
Air dry
Dispose gloves and wipes in red bag
Dispose of red bag as hazardous material

Laundering Towels and Lab Coats

OSHA: “Employees are not permitted to take their protective equipment home and launder it. It is the responsibility of the employer to provide, launder, clean, repair, replace, and dispose of personal protective equipment.”

Every hand therapy unit should have

- Hand sanitizer
- Gloves, exam and sterile, appropriate size(s)
- Eye protection
- Disposable towels
- Bleach
- Sharps box
- Biohazard plastic bags
- Separate refrigerators for therapy and food
- Separate breaks/food area away from treatment areas
Separate Work and Break Areas

- No cold packs in food refrigerator
- No food/drinks in cold pack refrigerator
- No eating in treatment areas

What should you do if you get a splashed in eye or mouth?

- Remove personal protective equipment
- Wash widely and copiously with soap and water
- Report to supervisor if hospital/clinic employed to internist or ER if self-employed
- Have tests for HIV and hepatitis C
- Assess cause and avoid in future

Today’s Objectives

Within the context of upper extremity wounds:

- Identify the components of wound evaluation and assessment
- Become familiar with wound terminology definitions

Wound Assessment

1) Needs emergent treatment
2) Needs ongoing treatment
3) Healing appropriately

Need universally understood terminology to describe wounds

Purpose of referral may change, wound healing is a dynamic process

- Prepare for surgical closure
- Facilitate closure though secondary intention
- Maintain graft or flap coverage healing
Abscess - pus under pressure

What else do you see?

Cellulitis/erythema/edema – red, hot, swollen

Abscess - pus under pressure

What else do you see?

Cellulitis/erythema/edema – red, hot, swollen

Necrotizing Fasciitis

Fluid or blood filled bullae (blisters)
Crepitus: crunchy, popping sound
[air bubbles in soft tissues]

A common example of healing by secondary intention

Superficial infection potential

- Non healing
- Exudative
- Red and bleeding surface
- Debris- Yellow or black
- Smell

NERDS

Fluid or blood filled bullae (blisters)
Crepitus: crunchy, popping sound
[air bubbles in soft tissues]

A common example of healing by secondary intention

Superficial infection potential

- Non healing
- Exudative
- Red and bleeding surface
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- Smell

CBSnews.com

Wound with devitalized tissue after near amputation in pt. with heavy nicotine use.

A common example of healing by secondary intention

Superficial infection potential

- Non healing
- Exudative
- Red and bleeding surface
- Debris- Yellow or black
- Smell

CBSnews.com
Deep infection potential

• STONES
  – Size is bigger
  – Temperature
  – ProObe, exposed bone
  – New areas of breakdown
  – Exudate, erythema
  – Smell

Wound Assessment

Health history, habits, roles, family medical history
Consider: tissue perfusion and nutrition for healing
– Immune system function, glucose levels, clotting disorders
– Alcohol, substance abuse, nicotine, caffeine, nutrition
– Skin: radiation, prior wound history

Medications, allergies
Those that interfere or interact with wound healing and tx.
– Exercise and sleep habits, AD for ambulation

Indexes for Wound Assessment

• Wound etiology
  – Trauma-mechanism, secondary dx
  – Other
  – Environment where injury occurred
  – Duration of wound
  – Prior treatments and responses
  – Surgical coverage is a good option

Inspection

• Redness, swelling, and warmth
• Cellulitis or red streaking
• Patient’s pain reports, fever
• Edema-measure

Wound Bed: Necrotic Tissue

• As tissues die, they change in color/consistency. Dead tissue retards wound healing.
• Color, Moisture content, Adherence, Size/Amount, Location

Color Evaluation of Tissue

• RED: Healthy granulation tissue and good blood flow—Keep wound bed moist
• YELLOW: Fibrous nonviable tissue, necrotic fat—Debride, Absorb exudate
• BLACK: Nonviable tissue—Thorough debridement, treat infection
• Yellow or Black does not always IMPLY infection. Culture must be positive.

© Marion Laboratories/Guerra 1988
Tissue Terminology

- Eschar: Black/brown, indicates full thickness injury
- Slough: Yellow/tan, thin, mucinous/stringy

Wound Location

- Body/UE diagram
- Refer to anatomical region
  - E.g.: medial volar distal 1/3 of forearm

Wound Size and Shape

- Measure length and width:
  - Clock method
  - Longest/widest portions of the wound
- Photography
- Same evaluator with same terms
- Assistant to help record

Wound Depth

- Wound surface to visible deepest part of the wound or clock method
- Saline moistened sterile cotton tip applicator
- Place fingers at location where applicator is flush with top of skin.
- Can be too shallow to measure

Undermining/Tunneling

- Undermining:
  - Wound edges are deeper than superficial epidermal edges
Exudate: Wound fluid/drainage that contains dead cells and debris.

Transudate: clear fluid
Serous: yellow and odorless
Serosanguineous: pink
Sanguineous: red, bloody, thin
Purulent: thick, white blood cells and living/dead cells which is yellow green brown

Exudate documentation

• Color/terminology
• Consistency
• Odor: After irrigation
• Amount
  – None: wound tissues dry
  – Scan-moist, no measurable exudate
  – Small: 25% of dressing
  – Moderate: 25-75% of dressing
  – Large: >75% of dressing, easily expressed
  – Copious: >90% of dressing

Temperature and Edema

• Temperature-excess warmth/coolness- temperature tape (normal 95 deg. F)
• Edema-fluid excess in tissues causing congestion to block the spread of infection
  – Circumferential measurements
  – Palpation at periwound area

Periwound terminology

Hyperkeratosis/rolled epidermal ridge

Maceration

Ecchymosis

Cellulitis

Exposed Structures

Tendon: Initially white organized tissue, later yellow and dry
Objectives

- Differentiate between use of wound dressings such as gauze, impregnated gauze, semipermeable films, hydrocolloids and foams
- Determine the appropriate use of topical agents based on wound characteristics
- Apply the latest evidence to your practice

What makes an “ideal” dressing?

- **Absorbs** and **contains** exudate without leakage
- **Impermeable** to water and bacteria
- Does not **contaminate** wound during dressing change by leaving particulate contaminants
- Avoids wound **trauma** with dressing removal
Confusing Choices

Gauze

- Pros: Inexpensive, readily available
- Cons:
  - Can adhere to wound if exudate is present
  - Painful to remove

Tulle Dressings (impregnated gauze)

- Examples: Adaptic, Xeroform
  - Gauze soaked in paraffin or petroleum

Pros: nonstick-doesn’t adhere to wound
Cons: migrates if placed over a small area

Semipermeable Film
(transparent film that allows gas exchange, but impervious to bacteria)

- Example: Tegaderm
- Pro: Transparent, wound visible
- Con: Non absorbent
- No good evidence regarding benefit

Hydrocolloids (eg: occlusive dressing with hydrocolloid matrix)

Hydrocolloid = water absorbing polymers
Liquefies on contact with wound exudates producing moist environment
Dressing is impervious to gas, bacteria, and liquid
Examples: Duoderm, Tegasorb

Hydrocolloid Dressing, continued

Pros:
- Warm, moist environment
- Less pain on dressing removal.
Cons:
- Retained moisture can macerate skin
- No through-bandage wound assessment
Effect of hydrocolloid dressings on healing by second intention after excision of pilonidal sinus

A Prospective RCT  European Journal of Surgery

Findings:
- Bacterial growth
  - 5 of 15 gauze control group
  - 1 of 23 hydrocolloid group
- Leakage
  - 0 of 15 gauze control group
  - 14 of 23 hydrocolloid group
- Pain
  - Gauze >> hydrocolloid

Bottom Line
- Per Cochrane Database:
  - “We were unable to identify a single large, high quality RCT in this area. Only 13, poor quality trials were found, while worldwide all kinds of dressings and topical agents are used in wound care for surgical wounds”

Wet to Dry Dressings
- Definition: a moist gauze is placed on the wound and allowed to dry, thus serially debriding crusted blood/exudate and necrotic tissue with dressing change
- Commonly used
- How does it compare?

Wet to Dry
Suboptimal
- Can delay wound healing by removing migrating epithelium
- Further cause pain by exposing sensitive nerve fibers in the wound bed
- May actually increase costs due to lack of effectiveness

Association for the Advancement of Wound Care Guideline of Pressure Ulcer Treatment

Hydrocolloid, foam, and alginate heal wounds **FASTER** than gauze

Foam and hydrocolloid have **FEWER** wound infections than gauze

Overall cost: foam and hydrocolloid < gauze

Alginates (a component of seaweed)
- Similar to hydrocolloid in that when in contact with the wound, it turns into a gel promoting a moist environment

Silicone foams
- Designed to absorb large amounts of exudate
Categories of Bacteria Ridding Agents

Bacteriocidals:
• Antibiotics: systemic or topical
• Antiseptics: topical only
• Disinfectants: not on tissues

Barriers:
Osmotic agents

Bacteriocidals: Topical Antibiotics
1. bacitracin
2. polymyxin B
3. neomycin (Neosporin)
4. $1 + 2 \quad \text{Polysporin}$
5. $1 + 2 + 3 = \text{Triple Antibiotic}$
6. mupirocin (Bactroban)
   only one with excellent activity against MRSA

Bacteriocidals: Antiseptics
• iodine
• hydrogen peroxide
• bleach
• silver, Silvadene (silver sulfadiazene)
• Bactine (antibiotic + lidocaine)

• Some of these chemical agents can kill healthy tissue in addition to the bacteria

Barriers: Petroleum Jelly
• AKA White Petrolatum, AKA Vaseline, AKA soft paraffin
• Acts as a barrier between wound and bacteria outside

Total Occlusive Ionic Silver Containing Dressing vs Mupirocin Ointment Application vs Conventional Dressing in Elective Colorectal Surgery: Effect on Incisional Surgical Site Infection
• Prospective RCT with 147 pts
• Topical mupirocin ointment better results than silver-containing or standard dressing

Infection and allergy incidence in ambulatory surgery patients using white petrolatum vs bacitracin ointment. A randomized controlled trial.
• 922 patients with 1249 wounds
• Bacitracin and white petrolatum performed equally
  – low infection rate
  – minimal risk for induction of allergy.
Osmotic Agents: Honey

- Creates moist healing environment
- Antibacterial — Possibly due to high osmolarity
- Hydrogen peroxide released by exudate
- Stimulates healing and epithelialization

Honey
- Wound healing with honey — a randomised controlled trial
- 42 wounds treated with honey
- Safe, satisfying and effective healing agent
- Extremely cost effective.

Osmotic Agent: Sugar

- Cane sugar paste
- May prevent bacterial growth by lowering water activity available
- Also has osmotic effect helpful for debridement

Osmotic Agent: Epsom Salts (magnesium sulfate)

- Hypertonic solution
  - Draws fluid out of a wound and dries up weeping abrasions or scratches
  - Does not penetrate skin: soaking in a warm bath may have a soothing effect and give the skin a softer feel

Effects of honey and sugar dressings on wound healing
- RCT with 40 patients
  - 18 sugar dressings and 22 honey
- Honey was more effective than sugar
  - reducing bacterial contamination
  - promoting wound healing
  - slightly less painful
Chemical Cautery (silver nitrate)

Kills hypertrophic granulation tissue (pyogenic granuloma)

May suppress granulation sufficiently to allow for epithelium to close over

Cost Analysis

- How much would it cost to cover this wound?
  - Plain Gauze = $.05-.10
  - Adaptic = $.20
  - Xeroform = $.35
  - Tegaderm = $1.20
  - Hydrocolloid = $2.50

Summary

- Dry gauze is painful to remove and may impede wound healing
- Wet to dry dressings may actually decrease effectiveness and increase costs
- Mupirocin is more effective than silver dressings and has activity against MRSA
- Honey is a safe and effective healing agent

REFERENCES


Bolton et al. The Association for the Advancement of Wound Care (AAWC) venous and pressure ulcer guidelines. Ostomy Wound Manage. 2014 ;60:24.


Mechanical Treatments for Hand Wounds
Michael Rivlin, MD
Hand and Upper Extremity Surgery
Rothman Institute
Thomas Jefferson University

- Types of healing
  - Primary intention
  - Secondary intention
    - Implies granulation tissue

- Wound Biology
- Debridement / Cleansing
- Dressings / Dressing Materials
- Closure / Wound Stimulation

- Granulation tissue will close most wounds
- Which wounds won’t heal?
  - Exposed structures
    - tendons
    - vessels
    - bone
    - hardware
Normal Phases of Wound Healing

1 month
6+ months

• control pain
• minimize edema
• prevent / eradicate infection
• encourage collagen deposition
• encourage collagen maturation
• encourage angiogenesis
• prevent excess granulation

Commandments

Optimize health
Remove physical barriers
Reduce bacteria
Control moisture
Reduce or reverse stress

Red / Granulating Wound
– Goal: protection
– Debridement: N/A
– Cleansing: Water
– Topicals: N/A
– Dressing: protective, maintain moisture

Necrosis / Eschar
– Goal: remove mechanical barrier to healing
– Debridement: Sharp / Surgical
– Cleansing: Soap and Water
– Topical Treatment: N/A
– Dressings: WTD, moisturize
• Exudative
  – Goal: eliminate debris / bacteria without harming healing tissue
  – Debridement: scrubs, irrigation
  – Cleansing: soap and water
  – Topical: Silvadene, Bacitracin, Etc.
  – Dressing: WTD, absorbants

• Wound Biology
• Debridement / Cleansing
• Dressings / Dressing Materials
• Closure / Wound Stimulation

• Drains evacuate hematoma

• Sharp debridement
  – Viable or not viable?
    • Color
    • Consistency
    • Contractility
    • Capacity to bleed

• Solutions
  – Gravity irrigation works
  – Additives unnecessary
    • Betadine, Dakin’s, Hydrogen Peroxide...
    • ...kill granulation tissue
    • Use to remove already dead tissue
"The only solution that should be used in a wound is one that can be poured into the physician’s eye."

- Wet to dry dressings
  - Will debride necrotic tissue
  - Will damage granulation tissue
  - Not to be used on exposed tendon, bone
  - May do more harm than good

- Whirlpool
  - Sterility issues, time consuming
  - Useful for
    - loosely adherent necrotic tissue
    - soaking off dressings
    - diluting contaminants

- Maggots
  - May be sterilized
  - Necrophages
  - Extracorporeal digestive system
  - Crawl
  - Bite

- Wound Biology
  - Debridement / Cleansing
  - Dressings / Dressing Materials
  - Closure / Wound Stimulation
• Dressings:
  – Goal is homeostasis – i.e. protection from:
    • bacteria
    • desiccation
    • maceration
  – More “feel” than science
  – Know what type of wound you’re treating

• Films
  – Allow visual monitoring
  – $$

• Cotton gauze
  – inert
  – adherent
  – not a barrier
  – $

• Hydrofiber: Aquacel
  – Absorbent
  – Antimicrobial: Ag
  – $$$

• Semipermeable Foams
  – Absorbent
  – $$$

• Hydrocolloids:
  – Absorbant
  – Maintain moisture
  – $$$
• Dressing materials continued
  – Little evidence for Xeroform
  • Makes dressing removal easier
  – Silvadene, Bacitracin
  • Useful in Yellow wounds
  – Salt?  Sugar?
  • Highly Hydrophillic

• HYPERgranulation tissue
  – Debridement
  – Friction control
  – Absorbent dressings

• Wound Biology
  • Debridement / Cleansing
  • Dressings / Dressing Materials
  • Closure / Wound Stimulation

• VAC dressing
  – Edema / hematoma control
  – Increased blood flow
  – Mechanical shrinking
  – Mechanical stimulation
  – Portable

• VAC CONTRAindicated
  • Necrotic tissue
  • Osteomyelitis
  • Malignancy
  • Exposed Vessels

“Wounds heal faster in plaster.”
• Hyperbaric oxygen
  – Effects systemic
  – Angiogenesis
  – Growth Factors
  – Antimicrobial
  – Proven for diabetics
  – 90 min / day x 30
  – Does not work on necrotic tissue

• Electrical Stimulation
  – intact skin has electrical potential
  – broken skin allows for flow of current
  – chronic wounds lose flow
  – preliminary data suggest role

• Low-level laser therapy
  – Painlessly penetrates superficial tissue
  – Causes proliferation of cell lines
  – Too much can be harmful
  – Hard to standardize / study

• Ultrasound
  – Unproven
  – Many unanswered questions
    • how much, how long?
**Conclusion**

Scar Maturation and Modeling

Chelsea A. Barker, OTR/L
Rothman Institute


**Scar Definitions**

**Hypertrophic:** within bounds of injury, flattens over time

**Keloid:** out of bounds, no change over time, rare in hands

**Phases of Wound Healing**

- I. Hemostasis
- II. Inflammation
- III. Fibroplasia
- IV. Maturation

Scar Characteristics: height, width, color, texture

Scar Maturation: Natural Course, min 6-12 months

Scarring varies by...
Age: young adults > children and elderly >>> fetal
Skin color: dark >> light
Body area: trunk > shoulder >> palm
Mechanism of injury: burn > others
Orientation to skin creases: ↓ >> ||
Individual: genetics

Results of scar modulation studies muddled by
Inconsistent definitions of keloid vs hypertrophy
Different body sites
Different injuries
Different individuals
Lack of adequate controls
Different dosages/duration of treatment
Inadequate length of follow-up
Commercial bias

Best studies: randomized, double blinded, “split scar studies” (patient serves as own control)

Theoretical Mechanisms for Some Scar Modulation Modalities
Let’s look at these for quality of evidence, then some other modalities too.

Silicone Sheeting
Systematic review of trials evaluating silicone gel sheeting
• improvement in scar thickness and scar color
• studies poor quality and highly susceptible to bias

O’Brien, Jones: Silicone gel sheeting for preventing and treating hypertrophic and keloid scars. Cochrane Database Syst Rev. 2013 Sep 12
Silicone Gel
Level 1 evidence from split-scar study:
- Effect is from hydration of superficial skin layer not from pressure, temperature, or chemistry of silicone

Vitamin E
Anti-oxidant properties
Multiple studies: no convincing evidence of efficacy

Aloe vera
Centuries-old traditional medicine
No convincing evidence for benefit

Green tea
Anti-oxidant/anti-inflammatory properties
Inhibits collagen production in laboratory
Only limited and low-level clinical evidence

Onion extract gel (Mederma)
Anti-oxidant/anti-inflammatory properties
Reduces fibroblast cell culture proliferation
2 RCTs showed + results, both funded by mfr
Other studies: generally favorable results

Pharmaceuticals
TOPICALS
Mitomycin C
anti-tumor/antibiotic
inhibits DNA synthesis, cell proliferation, keloid fibroblast formation in cell culture
clinical results mixed

Imiquimod
immune response modifier
useful for warts and other viral conditions
results for scars mixed at best

INTRA-LESIONAL INJECTIONS
Verapamil
calcium channel blocker
stimulates collagenase production
intra-lesional injection
limited studies, but effective

Triamcinalone
corticosteroid—anti-inflammatory
intra-lesional injection

Injections for Scar Modulation
Review of 27 papers
Alone or in combination and with/without excision
• 5-fluorouracil
• mitomycin
• bleomycin
• steroid injections, esp triamcinalone

Combined agents following surgery worked best
• Recurrence incidence 6-19%

Other Modalities
Radiation
• 33 midlevel studies
• Radiation within 7 hours after excision -> low recurrence
• Reports with higher levels of evidence needed

Laser: “photobiomodulation”
• Basic science evidence is poor
• Substantial divide between the basic science rationale and clinical evidence of efficacy
• Blinded studies difficult
• Settings may not accurately indicate dose

Tamoxifen: inhibits estrogen, delays fibroblast proliferation
• One level 1 study: “It seems to work.”
What Is True About Scar Modulation

**Time and Topicals**
- Patience is rewarded over at least 6-12 months
- Silicone gel definitely helps
- Mederma likely helps
- Vitamin E does not help

**Invasive Interventions**
- Excision with injections help
- Excision with radiation help

Further Investigation Requires

Serial quantification of scar
- Vancouver burn scar assessment, others
- Photos w/ standard lighting/positioning/background

Serial outcomes measures
- PRISM (Patient-Reported Impact of Scars Measure)

Understanding scar formation on a molecular level
- New Molecular Medicine-Based Scar Management Strategies. Burns. 2014;40: 539 Free full text

The Right Way to Study Scar Modeling

<table>
<thead>
<tr>
<th>HISTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous history of similar scars?</td>
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<tr>
<td>History of current scar? (Cause? Age? Changes? Response to treatment?)</td>
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<tr>
<td>Family history of abnormal scars?</td>
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**Structured/Clinical Assessment**

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Score</th>
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<td>Vascularity</td>
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**Treatment**

- Scars
- Tissue
- Physical/Pathological
- Laser Doppler imaging
- Blood Flow
- SIASc: Vein/Melanin/Collagen

**Follow-up/Re-Evaluate**

- As scar matures, characteristics may change over time

Vancouver Burn Scar Assessment

<table>
<thead>
<tr>
<th>Scar characteristic</th>
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Total score = 13

Patient-Reported Impact of Scars Measure (PRISM)

37 items: Symptoms and Quality of Life

**Symptom Scale**
- My scar throbs quite a bit
- The pain is very severe
- My scar itches a lot
- My scar is very sensitive
- Clothes make my scar hurt

**Quality-of-Life Scale**
- It affects my confidence
- The pain is very severe
- It’s really annoying having to explain it
- I feel embarrassed when people ask about my scar
- I feel very unattractive
- I can’t see past the scar when I look in the mirror


Moisture, not pressure provided benefit.


Tamoxifen proved effective in preventing post-surgical hypertrophic scars.

A comprehensive evidence-based review on the role of topicals and dressings in the management of scar scarring. Arch Dermatol Res 2011; 303(6):461-477. FREE FULL TEXT

Silicon gel sheeting for preventing and treating hypertrophic and keloid scars. Cochrane Database Syst Rev. 2013 Sep 12


* = Level 1 evidence
Management of Clean Incisions

Cynthia Watkins PT, DPT, CHT
Manager of Hand Therapy
Rothman Institute

Objectives

• Identify types of surgical and non-surgical closures
• Determine when it is safe to remove sutures/closures
• Pin care

Surgical Closure

Goals
• Allow wound healing by primary intention
• Approximate skin edges to:
  – Minimize inflammation
  – Minimize edema
  – Minimize scar formation

Clean, well approximated skin edges re-epithelialize in 24-48 hours

Carpal tunnel incision with early dehiscence and prolonged inflammatory phase of wound healing

Prolene sutures

• Erythema
• Wound dehiscence
• Delayed healing

* = Level 1 evidence
Vicryl (dissolvable)sutures

Subcuticular Suture

Appearance after deep dermal closure (absorbable)

Appearance after subcuticular closure (absorbable)

Basic rules

• If dry...moisten (ointment, xeroform, tape, glue)
  — Petrolatum equivalent to antibiotic ointment without the risk of allergy
• If wet...dry (gauze, alginate, hydrocolloid)
• Crust is a biofilm (full of bacteria). Remove it.

Basic rules

• If dry...moisten (ointment, xeroform, tape, glue)
• If wet...dry (gauze, alginate)
• Ointment only effective until epithelialization (24-48 hours)
• Crust is a biofilm (full of bacteria). Remove it.
• If tension...leave sutures/dressing longer and consider immobilization
• If signs of poor healing, leave sutures longer or remove offending agent (e.g. splint that's rubbing)

Not all incisions are the same

Consider the operation and the patient

• Patient factors:
  — Diabetes, age, obesity, chronic disease, malnutrition, smoker, radiation, tension, motion (flexion crease)
• Operative factors:
  — Primary site or multiply operated on
  — Blood supply
  — Hardware or foreign body (e.g. Hunter rod)

Suture Removal

• When to remove subcutaneous suture?
  — If absorbable, can leave it or trim end at skin
  — If permanent, remove at 14 days (or longer)
  — Suture through skin doesn’t cause infection (at least for a few weeks), though the tract will epithelialize
Simple Interrupted Suture

NOT all erythema is an infection

Suture Removal

- When to remove interrupted suture?
  - Depends on layers. If multiple layer closure, top layer can be removed at 5-7 days
  - If single layer, keep sutures longer (10-14 days)

Example of Primary Wound Healing

1 month                        2 months
s/p open carpal tunnel release

Non Surgical Closure
Adhesive Tapes (Steristrip®)

- Can allow to fall off on their own
- Can reapply
- NOT for mobile areas (will fall off)
- NOT for glabrous skin
- Beware swelling

How I Do It: April 2015 Survey Results

<table>
<thead>
<tr>
<th>HAND</th>
<th>BUSINESS OF HAND</th>
<th>Does any of this matter?</th>
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10/18/2016
Putting this in perspective

Evidence in carpal tunnel surgery

100 patients had open carpal tunnel release
- 51 randomized to have dressing removed after 2 weeks
- 49 randomized to have dressing removed after 24 hours

No difference in complications. Slightly improved functional scores in 24h group.


Dermabond (2-Octyl Cyanoacrylate)

- Sterile liquid topical adhesive – “medical superglue”
- FDA approved 1998
- Strong, waterproof (4-0 suture equivalent)
- Classically not used in hand unless immobilized (can crack)
- Not removed – sloughs with epidermal turnover in ~14 days
- Can cause hypersensitivity reaction

Pin Care

Clean interface daily with saline and Q-tip
Anything stronger cytotoxic
Remove crusting
Increasing erythema, pain: oral antibiotics
Pus: possible early removal of pin
Pin loose: remove

Some hints from my practice

- Become familiar with your surgeon’s preferences/protocols
- Educate your patient on the signs of infection and dressing changes at the first postop visit
- Make sure your patient has dressing supplies and written handouts on application before leaving the office-especially on Fridays!

Reading


- THANK YOU!
Managing Open Wounds

Jonas L. Matzon, MD
Rothman Institute
Hand, Upper Extremity, and Microvascular Surgery
Associate Professor of Orthopaedic Surgery
Thomas Jefferson University, Sidney Kimmel Medical College

* No conflicts of interest *

Wound Assessment

- History
  - Underlying medical comorbidities
  - Social history
    - Tobacco, EtOH, occupational exposure
  - Wound
    - Mechanism
    - Time course
    - Previous treatment

- Physical Examination
  - Size/location of wound
  - Involved structures
  - Cleanliness
    - Purulence
    - Drainage/odor/erythema
    - Granulation vs necrotic tissue

- May require formal debridement to fully appreciate!

Wound Characteristics

- Physical Examination
  - Size of wound and involved structures
    - Location
    - Depth
    - Volume
  - Cleanliness
    - Purulence/drainage/odor/erythema
    - Granulation vs necrotic tissue

- May require formal debridement to fully appreciate!

Why Wounds Fail To Heal

- Diabetes
- Obesity
- Smoking
- Immunosuppression
- Chemotherapy
- Radiation
- Malnutrition
- PVD
- Infection
- Surgical technique

Reconstructive Ladder

- Free tissue transfer
- Distant flaps
- Local flaps
- Skin grafting
- Primary closure
- Secondary intention

Secondary Intention

- Rationale:
  - Loss of full thickness skin initiates wound contraction

- Mechanism:
  - Fibroblasts migrate into wound
  - Differentiate into myofibroblasts
  - Pull wound edges together
Secondary Intention

- **Advantages:**
  - No risk of infection
  - Good restoration of sensibility

- **Disadvantages:**
  - Long time to complete healing

- **Technique:**
  - Wet-to-dry dressings BID/TID

---

I&D

1 Week

2 Weeks

4 Weeks
**Primary Closure**

- Skin edges sutured together
  - Must avoid too much tension
  - Edges should be everted

- Requirements:
  - Acute wound
  - Clean wound without debris

- Advantages:
  - Simplifies wound care
  - Wounds heal quicker
  - Better cosmetic outcome

**Skin Grafting**

- Indications:
  - Any defect with good wound bed that cannot be closed

- Contraindications:
  - Poor wound vascularity
    - Grafts placed on bone, joints, or tendon (without epitenon) have lower survival
    - High bacterial content (>10^5 bacteria/gram)

**STSG**

- Epidermis and varying levels of dermis

- Advantages:
  - Ability to survive on beds with limited vascularity
  - Ability to cover large wounds

- Disadvantages:
  - Sub-optimal cosmesis
  - Less durability
  - Greater propensity for contracture
FTSG
• Epidermis and full-thickness dermis

• Advantages:
  - Better wound protection
  - Better sensibility due to greater reinnervation
  - Less wound contracture
  - Faster maturation

• Disadvantages:
  - Higher rate of infection
  - Need for better vascularized bed
  - Lower survival rate

STSG

STSG

STSG

FTSG

FTSG

FTSG
Local Flaps

- Flaps from skin adjacent to the primary defect

- Types:
  - Advancement
  - Rotational
  - Transpositional

- Advantages:
  - Provide well vascularized, full thickness coverage
  - More durable to friction/stress than skin grafts
  - Ideal in terms of color/consistency match
Reconstructive Ladder

- Free tissue transfer
  - Distant flaps
  - Local flaps
  - Skin grafting
  - Primary closure
  - Secondary intention

Distant Flaps

- Come from elsewhere in the body
  - Regional flaps are from the same limb
  - Usually require at least 2 procedures

- Types
  - Random pattern: supported by vessels from subdermal or subcutaneous plexus
  - Axial pattern: blood supply from single vessel

Cross Finger Flap
Radial Forearm Flap

Groin Flap

Groin Flap
Free Tissue Transfer

- Highest rung on reconstruction ladder
- Transfer of autologous tissue from one location in the body to another using microsurgical techniques

Reconstructive Ladder

- Free tissue transfer
- Distant flaps
- Local flaps
- Skin grafting
- Primary closure
- Secondary intention

Lateral Arm Flap
Introduction: “A burn is for life”

- Hand = 3% TBSA
- Hand burns = 80% burn injuries

Thermal Injuries: Concepts

Mechanism of Injury

- Thermal Injuries
  - Scalds
  - Flame burns
  - Flash burns
  - Contact burns
  - Frostbite
- Chemical injuries
- Electrical burns
- Radiation burns

Thermal Injuries: Concepts

Classification

- 1st Degree (Superficial)
- 2nd Degree (Partial Thickness)
- 3rd Degree (Full Thickness)
- 4th Degree (Tendon/bone/jt)

Jackson's Zones of Injury

Zone I: Zone of Necrosis
Zone II: Zone of Stasis
Zone III: Zone of Hyperemia

Acute Thermal Injuries: Management
“Cool the burn, warm the patient”

- Acute Management:
  - Airway
  - Breathing
  - Circulation
- Debridement with Reconstruction
- Rehabilitation

First Degree Burns

Second Degree Burns: Superficial

Second Degree Burns: Deep

Second Degree Burns: Indeterminate

Third Degree Burns

Photos courtesy of Dr. Andrew Navarette

Photo courtesy of Dr. Prosper Benhaim
Fourth Degree Burns

Fourth Degree Burn Reconstruction

Fourth Degree Burn Reconstruction

Fourth Degree Burn Reconstruction

Escharotomy

Hand Burn Rehabilitation

- As soon as patient enters ER
- Elevation – can effect burn depth
- Intrinsic plus orthosis
- Supervised early motion
- Pressure garments (23hrs/day x 6-12 months)

Greene's Operative Hand Surgery 6th Ed, Figure 63.8
Post Burn Contractures

Best Treatment = Prevention

Photo courtesy of Dr. Roy Meals

**Frostbite**

“Nothing burns like cold”

- $< 15^\circ C$ – Adaptive hunting reaction

- Two mechanisms:
  - Direct cellular damage
  - Dermal ischemia

**Frostbite: Classification**

- **First degree** = reversible changes
- **Second degree** = superficial dermal damage
- **Third degree** = deep dermal damage
- **Fourth degree** = damage to subcutaneous tissue/muscle/nerve/bone

**Note:**

1) Severity cannot be determined acutely
2) Treatment directed at
   a) Promoting circulation
   b) Preventing infection
   c) Allow tissues to declare themselves over time


**Frostbite: Management**

- Rapid rewarming
  - To thaw ice & halt direct cellular damage
  - Avoid thawing until definitive rewarming possible
  - Water bath ($38^\circ C - 40^\circ C$) with mild antibacterial agent

- Post thawing rehab to minimize dermal ischemia

- Active wound care to promote healing
  - Early vs. late surgical intervention

**Frostbite: Patience Can Be Rewarded**

On admission

After rapid rewarming

8 days

12 days

84 days

Patience is USUALLY Rewarded

Frostbite: Patience Is Not Always Rewarded
• Demarcation of dry gangrene is obvious
• Time to remove necrotic tips

Frostbite Adjuvant Therapies:
- Evidence is weak
• Low-molecular weight Dextran
• Vasodilators – Resperpine
• Anticoagulants – tPA
• Sympathectomy
• Hyperbaric oxygen
• Early subatmospheric pressure wound therapy
• Prostacyclins

Bibliography
• Fufa DT, Chuang SS, Yang JY. Postburn contractures of the hand. J Hand Surg Am. 2014 Sep;39(9):1869-76.

13 Quiz and Closing Comments

Reinforcement Quiz
Honey has been used on open wounds since
medieval times
1928 Renaissance era
ancient Egyptian times
19th Century

Split thickness skin grafts transfer
epidermis
hair follicles
sensory end organs
sweat glands
all of the above

Skin provides
dermatization barrier
infection defense
vitamin D production
sensation
all of the above plus temperature regulation

Reinforcement Quiz
The first 3 phases of normal wound healing in sequence are
inflammation, fibroplasia, hematoma
fibroplasia, inflammation, maturation
fibroplasia, hematoma, inflammation
hematoma, inflammation, fibroplasia
hematoma, fibrinoid, inflammation

Scar maturation in normal wound healing
is complete upon suture removal
requires a minimum of 6-12 months
is entirely individual specific
produces permanent regional erythema
leads to progressive local induration

Wound healing is favorably affected by
Staph infection but not Strep infection
lymphedema
adequate oxygenation of tissues
volar locking plates and screws
low-moderate nicotine levels
Reinforcement Quiz

What are OSHA regulated wastes?
contaminated sharps
soggy dressings
caked, dried blood
pus on lab coat sleeve
all of the above

Drying fingers, then palms, then wrists after a surgical scrub is easy to remember because finger, palm, wrist are in alphabetical order softens the towel for the sensitive wrist skin bestows an air of professionalism moves towel away from cleanest, most critical skin surfaces allows the fingers more time to dry before donning gloves

Which wound description suggests a favorable outcome?
fetid odor, patchy necrosis
ascending lymphangitis
odorless pus
granulation without exudate
watery exudate, marked swelling

Wet-to-dry dressings may be less painful than non-adherent dressings promote faster healing than hydrocolloid dressings cause less bleeding on removal than honey-soaked gauze ultimately cost less than fancier alternatives remove new fragile epithelium

The rationale for use of Epsom salt solutions on open wounds is that the hypertonic solution draws excess fluid from the wound their antibiotic properties have been known since antiquity the salt solution stings less than pure water bacteria are repelled by magnesium the resultant skin softening eases pain

Use of a whirlpool to treat open wounds may pose sterility problems loosen necrotic bits of tissue soak adherent bandages loose dilute wound contaminants cause all of the above

Reinforcement Quiz

Benefits of negative-pressure assisted closure include control of hematoma and edema increase in local blood flow mechanical shrinkage of the wound stimulation of granulation tissue all of the above Keloids on the hand are avoided by layered wound closure identical to hypertrophic scars fragile and bleed easily easily managed with topical silver nitrate rare in all races Triple antibiotic ointment costs three times as much as regular good for wounds undergoing tertiary healing has three times the potency of other ointments contains penicillin, sulfa, and cipro contains bacitracin, polymyxin B, and neomycin

High level evidence supports that scar modulation is favorably affected by Vitamin E, pressure silicone gel, time low level laser, ultrasound xylazine and platelet-rich plasma injections all of the above

An escharotomy releases endorphins into extra-cellular space tight, circumferentially constricted skin endorphins into venous circulation pressure and pain receptors in epidermis proteases and collagenases into scar Early amputation of seemingly necrotic tissue in frostbite is contra-indicated because phantom pain is worsened by early surgery viable/nonviable demarcation may not be evident for months insurance company may first request second opinion patient needs time to emotionally adjust to the severity of the injury risk of infection is increased in tissues with cold sensitivity

CONGRATULATIONS
You may find it helpful to remember the quiz answers And for future learning......
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Please pick up around you.

On Monday, complete the quiz and evaluation form at www.doctorsdemystify.com and receive your CE certificate

The next 2 slides will include directions to the course quiz and certificate.

Your course certificate is available online after you complete and pass the course quiz. Here are some instructions.

• Go to www.doctorsdemystify.com
• Go to the left hand side of the screen and click "Log In"
• Input your Username & Password

• Select "Log In"
• Then look to the left hand side of the screen and select "My Courses"
• Under "My Courses" look for "Purchased Courses" and under that select "Wound Care"
• Once you get to that page select "Start Course" and then your course will be "In Progress"

• Scroll all the way down to the bottom of the page and select "Cartilage Ligaments & Fascia Quiz"

After you complete and pass the course quiz here are the instructions to retrieve your course certificate.

• Go to "My Courses"
• Then select "Completed Courses"
• Go to "Cartilage Ligaments and Fascia"
• Hit "View Certificate"

If you have any questions please email info@ddhands.com