MANAGEMENT OF HAND BURNS

Including Tips and Tricks for the Hand Therapist Treating Wounds, Grafts and Flaps

Nora Barrett, MS, OTR/L, CHT
Hand Specialist
Burn Rehabilitation Therapist
Bend, OR
Why Hands?
Objectives

• Identify burn wound characteristics, surgical options, and therapy priorities to promote healing and recovery

• Identify major components of hand rehabilitation throughout phases of burn recovery

• Recognize the purpose and use of orthotics throughout phases of burn healing and scar formation

• Identify biomedical and topical wound coverings that may be useful in treating non-burn wounds in the outpatient setting
Burn Depth

- **1st Degree** —> Epidermis (.05mm-1mm in adult)
  - Non-vascular, stratified epithelial cells
  - Capable of rapid regeneration

- **2nd Degree** —> Dermis (10 times thicker than epidermis)
  - Vascular layer containing collagen strands with nerve endings, hair follicles, oil & sweat glands, lymph spaces
  - Epidermal cells line deep structures in dermis

- **3rd Degree** —> Subcutaneous tissue
  - Adipose tissue & fibrous connective tissue

- **4th Degree** —> Muscle or bone
Depths of Burn Injury
SUPERFICIAL THICKNESS

- 1st degree burn
- Epidermis only
- Pink or red
- Erythema due to vasodilation
- Painful
- Characterized by cell damage without cell death
- Complete scarless healing within 7 days via re-epithelialization
PARTIAL THICKNESS
(Superficial)

- 2nd degree burn
- Epidermis, superficial dermis**
- Pink or red
- Blistering
- Wet, weepy
- Soft, blanchable
- Very painful
- Rapid, complete healing
- Relatively little scarring
BURN DEPTH

PARTIAL THICKNESS (Deep)

- 2\textsuperscript{nd} degree, potential conversion to 3\textsuperscript{rd} degree
- Most of dermis
- Red with overlying eschar
- Relatively insensate, potential for pressure
- Delayed healing potential (poor quality)
- Copious scarring
BURN DEPTH

FULL THICKNESS

• 3rd or 4th degree burn
• White, brown, tan, black or red
• Dry and leathery
• Firm, non-blanchable
• Insensate
• No potential for healing
• Profuse scarring if closes without excision, grafting (3rd)
• Elaborate debridement/reconstruction/amputation (4th)
BIOLOGICAL DRESSINGS & WOUND COVERAGE
Commonly Used with Hand Burns

- Aquaphor
- Xeroform
- Mepitel
- Mepilex
- Acticoat
- Silvadene
- VAC

1st Superficial 2nd
Deep 2nd
3rd/4th
AQUAPHOR

PROS:
- Easy, comfortable
- Inexpensive, OTC
- Under glove

CONS:
- Acne, ? reaction
- Thick, greasy
XEROFORM

**PROS:**
- Relatively easy
- Comfortable
- Allows relative mobility

**CONS:**
- Can be difficult under compression
- Cannot be used if wound bed already moist
MEPITEL

PROS:

• Preserves injured epithelium
• Reduced pain and trauma at removal
• Perforated- allows fluid drainage

CONS:

• Does not lower risk of infection
Mepitel in Hand Clinic
MEPILEX-AG

**PROS:**
- Used on any size area
- Can be left in place 4-7 days
- Donor sites
- Easy application

**CONS:**
- Indicated for low to moderate exuding wounds
- May need to be changed frequently with high exudate wounds
ACTICOAT

Pros:
- Effective vs. MRSA, VRE
- 7-Day Dressing
- Used on grafts and synthetics

Cons:
- Difficult to use on large wounds
- Must be kept moist
- Not transparent
- Silver chloride stain
SILVER SULFA<DIAZINE

“Silvadene”

PROS:
• Broad spectrum
• Not painful
• Lower cost
• 24 hour microbial coverage

CONS:
• Limited diffusion into eschar
Electrical
Chemical
EMERGENT PHASE
(Initial 72 hours post-burn)

Major Hand Considerations

• Edema
• Escharotomy
• Positioning
• Orthosis Intervention
• Motion
• Patient/family education
Post-Burn Edema
Escharotomy/Fasciotomy
Positioning
ORTHOSIS INDICATIONS

• Purpose: immobilize, support, position hand
• Characteristics: nonconforming, nonconstrictive
• Not standardized across burn units
• Many parameters for initiating orthotic use
• General indicators:
  – Sedated patient unable to participate
  – Significant edema resulting in clawing
  – Unable to actively achieve intrinsic plus position
  – Circumferential hand burn
ORTHOSIS INTERVENTION

- Dorsal Hand Burn
  - Intrinsic Plus: MCPs 70-90, IPs 0, thumb mid-radial/palmar ABduction

- Volar Hand Burn
  - Resting Pan: digit extension, full thumb ABd

- Circumferential Hand Burn
  - Alternate Intrinsic Plus and Pan Orthoses
  - Modify Pan for slight MCP flexion in deep dorsal hand burn to prevent clawing
Motion

- Preserve motion, prevent deformity
- Promote tendon gliding, active muscle function
- AROM as soon as awake, participating
- Full available motion in superficial dorsal injuries
- Protected ROM in deep dorsal hand burns
- Digital ABd/ADd considered safe for all depths
  - Activates intrinsics, mobilizes fluid
- ROM permitted after escharotomy/fasciotomy
- PROM in sedated patients
Cutaneous Functional Units (CFUs)

- Fields of skin associated with normal movement
- Skin recruited serially as joint ROM increases
- Most skin motion occurs at skin crease of joint but skin recruited beyond joint itself
- Contracture risk regardless if skin crease involved
- Isolated MCP vs composite flexion
  - No difference in recruitment of uninjured dorsal hand skin (excludes digits)
Elbow extension
Composite Fisting
ACUTE PHASE
(Emergent Phase through Wound Closure)

Major Hand Considerations

• Motion
• Tendon Integrity
• Persistent Edema
• Orthosis Intervention
• Functional use/ADL participation and modifications
Motion

• Minimize scar contraction, promote function
• Daily monitoring for loss of motion or limitations, initial deformity, maladaptive positioning
• Challenges in acute phase: pain, fibrous edema, increasing tautness, inelastic eschar
• What is limiting AROM? functional use?
• Disruption of the coordinated interplay of intrinsic and extrinsic muscles, tendons and joint is the underlying cause of most post-burn functional disturbances
TENDON INTEGRITY

• Continual wound assessment/inspection for exposed tendons

• Most common locations for extensor tendon exposure: PIP joint, dorsal hand

• Treat deep dorsal wound as if exposed until confirmed otherwise, skin healed or tissue covered

• Extensor tendon rupture/attenuation
  – Delayed healing dorsal digital wounds
PERSISTENT EDEMA

- Restricts motion, causes stiffness
- Can lead to tissue ischemia, fibrosis, progressive scar formation, deformity
- Compromised blood flow to hand, digits
  - Contributes to intrinsic tightness
- Fibrosis + thickened eschar can lead to delayed tissue death, “crushing effect” on extensor mechanism
- Treatment options/combinations
  - Fluff wrap, Coban, gloves
  - AROM, functional use
PERSISTENT EDEMA
STATIC ORTHOSES

• Purpose: prevent contracture
• Adjust for edema changes, decreasing dressing bulk
• Indications/Schedule:
  – Continue at night for optimal position
  – Limited use daytime if awake, participating
  – Intermittent daytime use with prolonged sedation or decreased functional use, maladaptive positioning
  – Uninterrupted use with tendon exposure
• Position ET on slack to prevent rupture but prevent excessive shortening
PIN FIXATION

• Deep, non-healing wounds unresponsive to orthosis

• Likely tendon/joint exposure with loss of extensor mechanism

• K-wire pins driven through MCPs in maximal flexion, IPs in 0 degrees extension

• Pins kept in place up to 6 weeks for temporary positioning, >6 weeks for permanent positioning until pseudo-arthrodesis via scarring
K-Wire Pinning
Delayed Pin Removal
MOBILIZATION ORTHOSES

• Adjunct to active exercise, manual stretching
• Force application amount determined by tissue response
• Dynamic traction used for early stiff hand
  – “Subtle suggestiveness”
  – Ideal when PROM responds to stretch, inflammation subsiding
• Cautious use of composite mobilization orthoses until dorsal wounds closed
CONTRACTURE IN BURN INJURY
(at time of hospital discharge)

• Small joints
  – 23% at least 1 wrist or hand joint contracture

• Statistically significant predictors of contracture development
  – Concomitant medical problems, TBSA grafted, presence of hand burn and hand grafting

• Statistically significant predictors of contracture #
  – Length of stay, concomitant medical problems, burn size, presence of hand burn and hand grafting

Contractures in Burn Injury Part II: Investigating Joints of the Hand
J Burn Care & Research, 2008
OPERATIVE MANAGEMENT/ SKIN GRAFTING

• Continual monitoring for signs of healing or conversion
  – Time & color
• Early predictors
  – Location, mechanism, age/health,
• Early excision & grafting
  – Limits/negates acute phase
  – Shortens fibroblastic stage
  – Speeds up healing, discharge and return to work/school
  – Best functional outcome
WOUND COVERAGE (SURGICAL)
Commonly Used with Hand Burns

- Xenograft
- Homograft
- Autograft
- VAC
- Integra
- Flap
XENOGRAFT Pigskin
aka EZ Derm

- Temporary wound coverage
- Minimizes fluid loss
- Controls pain via nerve ending coverage
- Stimulates re-epithelialization
HOMOGRAFT/ALLOGRAFT

Cadaver

- Extended temporary wound coverage
- Tests recipient bed for viability
- Decreases pain
- Protective covering/seals wound
  - Reduces heat loss
  - Prevents infection
  - Minimizes fluid loss
AUTOGRRAFT
Patient’s Own Skin

- Permanent coverage
- No risk of rejection
- Skin depth and color matching
- Sheet for optimal cosmesis, durability
- Meshed for enlarged coverage area
- Donor site can be reharvested
SPLIT-THICKNESS SKIN GRAFT (STSG)

• Most commonly used autograft
• Includes epidermis and part of dermis
• Vascular ingrowth within 24-28 hours
• Typically harvested from ipsilateral anterior thigh
• Donor site requires wound care, dressing
• Initial sensibility 4-6 weeks
FULL-THICKNESS SKIN GRAFT (FTSG)

• Less common but standard of choice for palmar wounds
• Includes epidermis and dermis
• Advantages
  – Increased depth-->higher quality coverage
  – Less contraction within wound bed
• Disadvantages
  – Harvest site requires skin graft
AUTOGRAFT

POST-OPERATIVE CARE

• Bulky post-op dressing to immobilize hand, digits and prevent shearing

• Dressing removed POD#3 for STSG, POD#5 for FTSG

• Assessed for “take” (%)
  – Adherence to wound bed
  – Viability
  – Presence of fluid pockets or hematoma
AUTOGRAFT (STSG) POST-OPERATIVE CARE

• Therapist role
  – POD#3-5
    • Trim excess autograft
    • Dressing to control edema, allow mobility
      – Xeroform, gauze, Coban
    • Resume gentle AROM** (fibrin glue)
  – POD#5 and beyond
    • Progress to limited dressing and edema glove
    • Intermediate pressure glove once little to no dressing
    • Advance to aggressive AROM, PROM and orthosis use as necessary, unrestricted ADL including shower
Autograft Trimming
WOUND VAC

**Advantages:**
- Enhances granulation tissue
- Less dressing changes
- OR or bedside

**Disadvantages:**
- Unable to visualize wound
- Difficult application to smaller hands
WOUND VAC APPLICATION
WOUND VAC
INTEGRA

• Bilayer matrix wound dressing

• Inner porous matrix allows rebuilding of blood supply, replaces dermis

• Outer silicone layer acts as epidermis, removed after dermal ingrowth for thin epidermal skin graft

• Closely monitored for infection
  – Serum collection removed daily to prevent failure, loss
FLAP

• Used for traumatic defects involving soft tissue loss
• Provides wound coverage/closure
• Local skin flap uses nearby skin and subcutaneous tissue
  – Rotational
  – V-Y Advancement
  – Cross-Finger
FLAP

- Used for traumatic defects involving extensive soft tissue loss, exposed bone/tendon, inefficient blood supply
- Axial flap for reconstruction of distal UE injuries
  - Groin flap
- Secure at 5 days, PROM initiated
REHABILITATION PHASE
(Wound Closure through Scar Maturation)

Major Hand Considerations

• Chronic edema
• ROM/Strength
• Skin integrity
• Scar characteristics
• Orthosis Intervention
• Physical Agents
• Deformity/contracture
• Return to work/school
CHRONIC EDEMA

• Source of progressive scar formation & restriction of motion
• Compounded by lymphatic/vessel damage
• Contributes to intrinsic, extrinsic tightness
  – Due to ischemia, fibrosis, ROM limitations
• Treatment options
  – Compression gloves, sleeves
  – Jobst compression pump (home)
ROM/STRENGTH

- Manual examination to determine which structures limit motion
  - Multiple positions, target tissue on slack & tension
- Must consider soft tissue structures beyond skin/scar
  - Intrinsic/extrinsic tightness, joint stiffness
- Resistive exercise in burn recovery
SKIN INTEGRITY

- Recurrent exposed tendons/joints
- Assess readiness for pressure
- Protect bony prominences from shearing, blistering in garments and with return to activity
SCAR

• Burn tissue healing
  – Prolonged inflammation
  – Overlap between healing phases
  – Synthesis-lysis imbalance
    • Problem healing: hypertrophy, keloid
• Stiffness due to increased collagen synthesis, lack of elastin in dermal layer
• Increased firmness in burn scar?
  – GAG chondroitin 4-sulfate 6x higher burn scar vs. normal skin (only GAG found in bone)
• Once mature, non-surgical treatment ineffective
SCAR ASSESSMENT

• Vancouver Scar Scale (VSS)
  – Most commonly used
• Patient and Observer Scar Assessment Scale (POSAS)
  – Developed in the Netherlands
  – Patient scale: color, pliability, thickness, relief, itching, pain
  – Observer scale: vascularization, pigmentation, pliability, thickness, relief
  – Concurrent validity with VSS
  – Suitable for rating burn scars

<table>
<thead>
<tr>
<th>VSS</th>
<th>Consistency</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pliability</td>
<td>.49</td>
<td>.69</td>
</tr>
<tr>
<td>Height</td>
<td>.76 (P)</td>
<td>.69 (O)</td>
</tr>
<tr>
<td>Vascularity</td>
<td>.73 (O)</td>
<td></td>
</tr>
<tr>
<td>Pigmentation</td>
<td>.76 (P)</td>
<td></td>
</tr>
</tbody>
</table>
SCAR MANAGEMENT

Pressure

- Alters disposition of collagen fibers in dermal hypertrophic healing
- Custom fitted pressure garments
  - Measured when remaining wounds no larger than quarter
  - “Intermediate” gloves/garments used in interim to control scar/edema, prepare skin
  - 2 sets for laundering
  - Worn 23 hours/day
  - Modifications for enhanced grip
SCAR MANAGEMENT

• Inserts
• Silicone gel
• Otoform
ORTHOSIS INDICATIONS

• Purpose:
  – Reduce non-surgical contracture
  – Prevent/reduce deformity
  – Maintain/promote natural body contours
  – Complement pressure treatment

• Goal:
  – Maintain sustained stretch to scar tissue
  – Maintain range achieved with stretch/ROM
  – Immobilize joint at end-range
  – Avoid pressure, excessive stretch
ORTHOSIS INTERVENTION

• Static
  – Thumb webspacer: 1st webspace tightness
  – PIP gutter: Boutonniere
  – DIP gutter: Mallet
ORTHOSIS INTERVENTION

• Static progressive
  – Significant resistance at end of passive stretch
  – Tension applied with joint at maximum range, adjusted when tissue response allows repositioning to new length
• MCP extension contractures
ORTHOSIS INTERVENTION

• Serial static (casting)
  – Resistive joint, firm to hard end-feel
  – Joint immobilized in stationary position, cast remolded at new maximum length after tissue accommodation
• Fixed contracture
PHYSICAL AGENTS

• Paraffin with sustained stretch
  – Most commonly used PAM with burns (cooler temp)
  – Softens skin, promotes increased tissue motion prior to exercise
• Iontophoresis (slow delivery)
  – Saline or iodine for scar softening
• Fluidotherapy
• Ultrasound: limited success treating burn scar
• Laser: multiple types for delayed scar treatment, prophylactic prevention hypertrophic scar w/o good evidence
DEFORMITY/CONTRACTURE

- Claw hand deformity
- PIP flexion contractures
- MCP HE contractures
- Flattened hand/loss of arches
- Boutonniere deformities
- Swan neck deformities
- Mallet deformities
- Nail bed deformities
- Palmar cupping
- Webspace contractures/Syndactyly
Boutonniere deformities

• More likely with deep dorsal hand, digits, thumb burns

• Mechanism of injury
  – Immediate: direct thermal injury to central slip
  – Delayed: tendon ischemia
  – Chronic: Scar banding &/or ORL tightness

• Arthrodesis is primary surgical correction option
  – Unsatisfactory tenoplasty options
  – No soft tissue coverage needed
Swan neck deformities

- MF incidence most prominent
- Causes for PIP hyperextension
  - EDC adherence
  - Intrinsic ischemic contracture
  - Joint stiffness/improper immobilization
  - Burn scar contracture
Mallet deformities

• Mechanism of injury
  – Immediate: direct thermal injury to terminal slip
  – Delayed: tendon ischemia (crushing of tendon between dorsal surface eschar and P3 base)
• Increased during PIP flexion
Nail bed deformities

- Mechanism of injury
  - Dorsal scarring over DIP with distortion of eponychial fold, eponychium retraction, proximal nail exposure

- Consequences of injury
  - Limits finger stability with pinching, fine motor dexterity
  - Cosmetically disabling

- Surgical treatment
  - Tightness w/o retraction= skin release, graft
  - Tightness with retraction= proximally based lateral skin flaps
Palmar cupping

- Mechanism of injury
  - Deep palmar burn (peds, contact)

- Consequences of injury
  - Thumb MCP HE contractures
  - Sensory deficits
  - Loss of stable grasping surface

- Surgical treatment
  - Multiple reconstruction procedures and extensive therapy
Webspace contractures

• Mechanism of injury
  – Adjacent digits burned (fingers fuse together)
  – Digital skin granulation or contractures allow distal web migration

• Consequences of injury
  – Limits digital ABduction and thumb opening
  – Cannot place thumb away from palmar plane

• Surgical treatment
  – Z-plasty variations (lowest recurrence rate)
  – FTSG if not sufficient skin
RECONSTRUCTION OPTIONS

- Scar resurfacing
- Webspace release
- Dorsal MCP release with autograft
- Excess skin or scar removal with primary closure
- Arthrodesis
RETURN TO WORK/SCHOOL

- Collaborative effort
- Referral to work-hardening program
- Strongest indicators
  - RTW time: % TBSA, grafting requirements, B hand involvement
  - Successful school re-entry: tutors during hospitalization, school environment/ personnel & peer preparedness
- MHQ: hand function deterioration 68%
- Most affected: ADL 76%, work 59%
RESOURCES & PROGRAMS
For Burn Survivors

• Phoenix Society  www.phoenix-society.org
  – Survivors Offering Assistance & Recovery
  – Image enhancement
  – Local support groups
• American Burn Association  www.ameriburn.org
• International Association of Firefighters
  – Regional Burn Camps
• Adaptive Sports Center, Crested Butte CO
  – Burn specific adaptive sports, outdoor programs
RESOURCES
For Therapists

- American Burn Association Rehabilitation Committee, Special Interest Group  www.ameriburn.org
- BurnTherapist.com
- Textbooks
  - Burn Care and Rehabilitation: Principles and Practice (Richard, RL)
  - Total Burn Care (2nd ed. Herndon)
  - Rehabilitation of the Hand and Upper Extremity (6th ed. Skirven et al)
Support was provided by:

Mölnlycke Health Care is a world-leading provider of single-use surgical and wound care products for customers, healthcare professionals and patients. Our products provide value to our customers and are supported by clinical and health economic evidence. And we strive to find new ways to minimize community and hospital-acquired conditions.

http://www.molnlycke.us/

Contact email for therapists: info.us@molnlycke.com
References

References

References


