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

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

- **2\textsuperscript{nd} 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

- **3\textsuperscript{rd} Degree** —> Subcutaneous tissue
  - Adipose tissue & fibrous connective tissue

- **4\textsuperscript{th} Degree** —> Muscle or bone
Depths of Burn Injury
BURN DEPTH

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
BURN DEPTH

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 SULFADIAZINE
“Silvadene”

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

CONS:
• Limited diffusion into eschar
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
Intrinsic Plus Orthosis
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
AUTOGRRAFT
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
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

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Consistency  Reliability
VSS    .49    .69
POSAS  .76 (P) .69 (O) .73 (O)
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 DIP 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)
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