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Therapist’s Management of Upper Extremity Burns

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Disclosures

- No financial disclosures
- No preference to mentioned products
Learning Outcomes

After this course, participants will be able to:

- Identify at least three burn wound characteristics.
- Identify at least two surgical options and therapies to promote burn wound healing and recovery based on the burn wound characteristics.
- Identify appropriate orthotics to use in each phase of burn healing and scar formation.
- Identify at least three wound coverings that may be useful in treating hand and upper extremity burns through the healing process.

Burn Depth

- 1st Degree: Epidermis (.05-1mm 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
Burn Depth

- **SUPERFICIAL THICKNESS**
  - 1st degree burn, epidermis only
  - Pink or red
  - Erythema due to vasodilation
  - Painful
  - 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)**
  - 2nd degree, potential conversion to 3rd degree
  - Most of dermis
  - Red with overlying eschar
  - Relatively insensate, potential for pressure
  - Delayed healing potential (poor quality)
  - Copious scarring

- **FULL THICKNESS**
  - 3rd or 4th degree burn
  - White, brown, tan, black or red
  - Dry & leathery
  - Firm, non-blanchable
  - Insensate
  - No potential for healing
  - Profuse scarring if closes without excision/grafting (3rd)
  - Elaborate debridement/reconstruction/amputation (4th)
Electrical

Chemical
BIOLOGICAL DRESSINGS & WOUND COVERAGE
Commonly Used with UE Burns

- Petrolatum topical
- Petrolatum gauze
- Transparent film
- Foam/Hydrofibers
- Active Leptospermum
- Antimicrobials
- Silver cream
- Negative Pressure Wound Therapy (NPWT)

PETROLATUM TOPICAL

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

**CONS:**
- Acne, ? reaction
- Thick, greasy
PETROLATUM GAUZE

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

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

TRANSPARENT FILM

- **PROS:**
  - Preserves injured epithelium
  - Painless
  - Perforated - allows fluid drainage
  - Can be removed and reused

- **CONS:**
  - Does not lower risk of infection
**FOAM**

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

- **CONS:**
  - Costly

**HYDROFIBERS**

- **PROS:**
  - Easy application
  - Does not require daily dressing change
  - Moderate to heavy exudative wounds
  - Absorbs wound fluid, forms hydrophilic gel
  - Contains antimicrobial agents
  - Conforms to wound surface

- **CONS:**
  - Adherence over joint can interfere with movement
  - Not compatible with oil based products
ACTIVE LEPTOSPERMUM

- PROS:
  - Helps lower wound pH and improve O2 transport
  - Draws fluid from wound, minimizes edema
  - Increases autolytic debridement
  - Useful on wounds containing slough and devitalized tissue
  - Effective antimicrobial agent against wide range of organisms
  - Can be used in combination with NPWT

- CONS:
  - Slower acting
  - Not recommended for full thickness wounds

Medihoney

ANTIMICROBIALS

- 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

Acticoat
**SILVER SULFADIAZINE**

“Silvadene”

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

**CONS:**
- Limited diffusion into eschar
- Changed daily

**EMERGENT PHASE (Initial 72 hours post-burn)**

Major UE Considerations

- Edema
- Escharotomy
- Positioning
- Orthosis Intervention
- Motion
- Patient/family education
Post-Burn Edema

Escharotomy/Fasciotomy
ORTHOSIS INDICATIONS

- Purpose: immobilize, support, position
- 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 digital clawing
  - Unable to actively achieve intrinsic plus position
  - Circumferential hand burn
  - Anterior elbow 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 hand 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 UE 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 hand 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
- “Figure of 8” reliable, valid method of measurement
PERSISTENT EDEMA

- Treatment options/combinations
  - Fluff wrap, Coban, gloves
  - AROM, functional use

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 digital 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, elbow
  - "Subtle suggestiveness"
  - Ideal when PROM responds to stretch, inflammation subsiding
- Cautious use of composite digital mobilization orthoses until dorsal wounds closed
CONTRACTURE IN BURN INJURY
(at time of hospital discharge)

- Most common large joints
  - Shoulder 38%, elbow 34%, knee 22%
- Statistically significant predictors of contracture development
  - Length of stay, extent of burn, graft
- Statistically significant predictors of contracture severity
  - Graft size, amputation, inhalation injury

Contractures in Burn Injury: Defining the Problem
J Burn Care & Research 2006

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, occupation
- 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 UE Burns

- Xenograft
- Homograft
- Autograft
- NPWT
- Integra
- Flap
XENOGRAFT
Pigskin

- 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
### AUTOGRAFT
**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

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### 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

AUTOGRAPH
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
NPWT/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

- 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 UE 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
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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 webspaces 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

- 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 flexion contracture: digital PIP, elbow, wrist
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 burn to dorsal hand, digits, thumb
- 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 (5th ed. Herndon)
  - Rehabilitation of the Hand and Upper Extremity (6th ed. Skirven et al)
References


References


References


