

Chapter 27:

Complex Traumatic Injuries

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- I. Complex Traumatic Injuries to the Hand^{1,2,3}
- A. Involves trauma to multiple anatomic systems of the hand resulting in a varied clinical picture.
The systems include:
 - 1. Skin - includes wounds and scar
 - 2. Vascular - arteries, veins, lymphatics; affects edema
 - 3. Tendon and muscle - implies ROM, strength, and functional/ADL use
 - 4. Skeletal - includes bones, joint capsules, ligaments; affects joint stability
 - 5. Nerve - affects sensibility, motor function, and pain
 - B. Potential Mechanisms of Traumatic Injuries:
 - 1. Motor vehicle accidents
 - 2. Machinery accidents
 - 3. Explosions
 - 4. Gunshots
 - C. Common names associated with traumatic or mutilating injuries of the hand
 - 1. Crush injuries (Fig. 1)
 - 2. Avulsion injuries (Fig. 2)
 - 3. Degloving injuries
 - 4. Complete amputations with or without replantation (Fig. 3)
 - 5. Partial amputations with or without revascularization
 - D. The overall goal of hand rehabilitation with mutilating injuries is to regain maximal functional use of the hand that is aesthetically acceptable to the patient. In the case of amputation with replantation, the hand must function better than one with a prosthesis.
 - E. Overview/Considerations
 - 1. Encourage patient to “buy in” to therapy. Explain the complex nature of the problem and the need for early intensive management.
 - 2. Give the patient and family realistic expectations on the scope, extent of therapy, and likely outcomes/deficits
 - 3. Explain early on that “normal” and “good as before” are not likely outcomes. The goal is achieving functional ROM, strength, and use.
 - 4. Educate patient to monitor for skin color or temperature changes that may indicate vascular insufficiency as well as signs of infection
 - 5. Educate patient to the benefits of reducing or eliminating the use of tobacco products and caffeinated drinks or foods. It is essential for the patient with microvascular reconstruction.
 - 6. Home programs should be well structured and easy for the patient to follow. The patient should demonstrate complete understanding before leaving the clinic. Patient educated in movement of all uninjured joints.
 - 7. Educate patient and family to maximize compliance and follow through
 - 8. Healing generally occurs in three phases
 - a. Acute phase – injury onset to approximately three weeks post op
 - b. Intermediate phase – approximately three weeks to eight weeks post op
 - c. Late phase – eight weeks on
- II. Evaluation of Multiple System Injuries^{1,2,4,5}
- A. When multiple systems are involved, the goals of treatment must involve protecting repaired structures according to their individual healing time frame, with respect to current status and precautions. Even though healing typically occurs in a continuum, complex injury may render

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- systems in different healing phases. This may include prolonged healing beyond “normal” timelines or overlapping phases.
1. Careful, thorough evaluation of overall injury will direct course of treatment
 2. Consider/evaluate damage and repair to each anatomical system
- B. History of current injury
1. Chart or operative note review – details of surgical repairs and precautions
 2. Circumstances of injury – date, work or non work related injury, other associated injuries
 3. X-rays if available
 4. Medications
 5. Communications with MD
 6. Patient information affecting treatment – age, hand dominance, past medical history, ADL functioning, vocational and avocational activities, family support
- C. Skin/Wound/Scar
1. After primary closure, clean wounds may close within 10-14 days
 2. More complex or dirty wounds may take longer to close due to risks of infection, prolonged inflammatory stage, or sub optimal closure
 3. Delayed closures or secondary procedures to close wound (i.e. grafts, flaps) require longer healing periods with special precautions
 4. Considerations:
 - a. Skin loss
 - b. Open wounds or fasciectomy
 - c. Type of closure- primary, delayed
 - d. Secondary closures – skin grafts, flaps
- D. Vascular
1. Blood flow is vital to the survival of revascularized or replanted structures
 2. Considerations
 - a. Vessels repaired or not repaired
 - b. Arterial and/or venous repairs
 - c. Any tension on vascular structures
 - d. Vascular patency
 - e. Precautions – blood thinners, elevation, warmth, no smoking, no caffeinated foods/drinks
- E. Tendon
1. Simple versus complex or multiple repairs
 2. Considerations
 - a. Repairs, implants (tendon rods)
 - b. Suture type and technique
 - c. Tension on repairs
 - d. Tendon quality
 - e. Balance of repairs (extension vs. flexion)
- F. Skeletal⁶
1. Minimum bone healing time ranges from 4-6 weeks, but bone continues to gain strength up to 12 weeks
 2. Stable or unstable fracture – unstable fractures will limit mobilization activities; whereas stable fractures will allow for more aggressive therapeutic management
 3. Fixation type/location may impede movement
 4. Early motion is dependent on stability and strength of fixation/repair
 5. Skeletal shortening will affect muscle and tendon function
 6. Considerations
 - a. Fractures, osteotomies, joint implants
 - b. Type of fixation (i.e. wires, plates/screws) – reviewing an x-ray or fluoroscopy helps determine what structures can or should be moved (Fig. 4)

Chapter 27 Figures

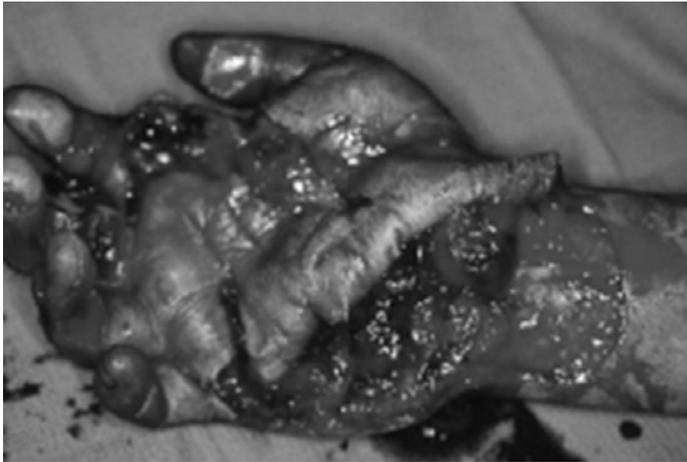


Fig. 1. Crush Injury.



Fig. 2. Rope Avulsion Injury.

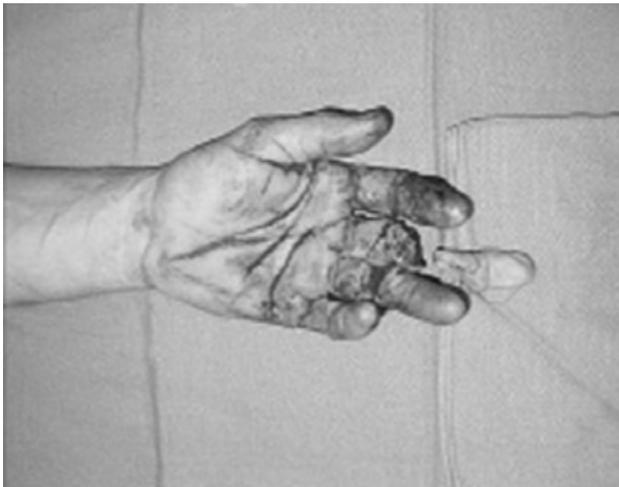


Fig. 3. Digital Amputation.



Fig. 4. X-ray of Bone Fixations.

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G. Nerve

1. Heals at rate of 1mm per day, from the repair site moving distally
2. Damage to peripheral nerve results in sensory, motor, and sympathetic fiber loss
3. Considerations
 - a. Type of repair – primary, nerve grafting (Fig. 5)
 - b. Tension on nerve repair

III. Therapist's Evaluation and Treatment for Skin/Wound/Scar^{4,5}

A. General Principles and Considerations

1. Wounds heal along a continuum
2. Most information on wound healing describes the clean, tidy, and uncomplicated wound
3. Wounds typically seen with mutilating injuries to the hand are characterized as untidy
4. Wounds are often complicated by extensive soft tissue and skin loss. Wounds can be contaminated, which changes the healing time frame.

B. Stages of Tissue Healing

1. Inflammatory Phase
 - a. This is often prolonged. Edema formation is often extensive due to significant soft tissue loss as well as damage to the lymphatic and superficial veins located in the subcutaneous tissue of the dorsum of the hand.
 - b. Inflammation may persist in response to ongoing tissue trauma (i.e. swelling, infection)
 - c. Epithelialization is prolonged secondary to extensive skin loss
2. Proliferative or Fibroplasia Phase
 - a. During fibroplasia: body heals all injured structures in same manner, resulting in one wound with one scar. Collagen in the form of scar tissue is produced at a rapid rate. As a result, many structures may become adherent in the same scar.
 - b. Scarring is extensive due to significant soft tissue loss and edema, which leads to joint fibrosis and tendon tightness. A stiff hand results if therapy is not aggressive in controlling edema and scar formation during this phase.
3. Maturation or Remodeling Phase
 - a. During the maturation phase: collagen lysis equals collagen synthesis. Treatment focused on vigorous reorientation of collagen fibers in dense, disorganized scar tissue to allow functional range of motion.
 - b. Treatment techniques are used to elongate scar adhesions that restrict motion and tendon gliding

C. Skin/Wound/Scar Evaluation – Acute Phase

1. General Information
 - a. Location
 - b. Measurements: width, length, and depth
 - c. Shape
 - d. Status of surrounding tissue
2. Exudate Characteristics
 - a. Color
 - b. Odor
 - c. Consistency (viscosity)
 - d. Adherent
3. Wound Bed Characteristics
 - a. Necrotic tissue
 - b. Granulation tissue
 - c. Epithelial budding
 - d. Vital structures exposed
4. Presence of Grafts and Flaps

- a. Adherence
 - b. Drainage
 - c. Vascularity
 - d. Viability
5. Signs of infection: redness, warmth, pain, edema, drainage, odor
6. Viability
- a. Dusky, grayish, decreased temperature, slow capillary refill indicates restricted arterial flow
 - b. Purple, cyanosis, abnormally rapid capillary refill indicates restricted venous outflow
- D. Skin/Wound/Scar Treatment - Early Phase
1. Complex injuries may include wounds in various healing stages
 2. Dressings (Fig. 6)
 - a. The purpose is to maintain a clean environment, prevent contamination, and minimize mechanical stress until extensive skin and soft tissue wounds heal
 - b. Bandages should cover all open areas but should be applied to minimally restrict motion or inhibit cutaneous input
 - c. Dressings should be applied in figure-8 fashion, distal to proximal, and should not be constrictive
 - d. Initially, dressings should be changed daily to observe wounds. If skin is macerated, dressing changes may be more frequent.
 - e. Well-approximated wound margins with signs of healing may only require dry dressings
 - f. Dressings for open wounds will depend on status of wound bed and exudate
 - g. The type of dressing applied to delayed primary and secondary closure wounds remains controversial, including the use of topical agents and types of bandage. Consult with referring physician for preferences.
 - h. With external hardware, such as K-wires or external fixators, patient should be instructed to perform pin care and monitor pin sites for signs of infection
 - i. Bandages should be carefully removed to avoid shearing forces on healing tissues, especially if grafts and flaps are present
 - j. Wound care should ideally be performed in a neutral temperature room, away from vents
 - k. Cytotoxic agents should be avoided or used minimally (peroxide, betadine, etc) due to their negative effect on healthy healing tissue
 3. Whirlpool^{4x} (Fig. 7)
 - a. Whirlpools may be contraindicated with complex injuries due to many precautions. This includes replanted or revascularized structures, unstable fractures, soft tissue damage, and loss of sensation. As a precaution to protect injured tissues, the agitator could be turned to a low setting or off, or another modality may be used.
 - b. Extreme caution should be used in replanted and revascularized structures as it places the hand in a dependent position below the heart
 - c. Temperature must be closely monitored or it may compromise the vascularity
 - i. Too cold may cause vasospasms
 - ii. Too warm may increase edema
 - iii. Shock of temperature changes may affect vascular status when removing the hand from water to room temperature
 - d. Whirlpools may be utilized for cleansing and debridement of superficial necrotic tissue
 - e. Mechanical effects of agitation
 - i. May stimulate granulation tissue, soften necrotic tissue, and increase circulation
 - ii. Agitation may also produce analgesic effect
 - f. Preferred temperature is 90-95 degrees F (32-35C), with the hand and forearm in an anti-gravity position

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- g. Following the whirlpool, the hand should be placed under running tap water to remove surface contaminants
 - 4. Debridement
 - a. General debridement may be performed via pulsed lavage
 - b. Selective debridement may be performed by hand with scissors and forceps
 - c. Autolytic debridement and debriding enzymes may be used to clean a wound
 - E. Skin/Wound/Scar Evaluation and Treatment - Intermediate Phase
 - 1. Re-evaluation
 - a. Continue to monitor wound status and response to treatment
 - b. If open wounds or external hardware still present, continue to monitor for signs of infection
 - c. Continue wound care as indicated; wounds should be smaller, likely less bandage necessary, pin care required if external hardware is present
 - 2. Scar management may begin 24 hours following suture removal except in cases of replant or revascularization
 - a. Transverse friction massage (Fig. 8)
 - b. Continuous pressure
 - i. Coban wrap®
 - ii. Compression tubes or sleeves (Tubigrip®, Digisleeves®)
 - iii. Isotoner® or Jobst glove®
 - c. Scar molds/pads
 - i. Elastomer®
 - ii. Otoform®
 - iii. Prosthetic foam
 - iv. Silicone gel sheet
 - 3. Care of residual limb/digit
 - a. Performed with complete amputations or fingertip injuries
 - b. Stump wrapping for shaping and edema control
 - c. Desensitization for hypersensitivity including massage, textures, vibration, particle immersion
 - F. Skin/Wound/Scar Evaluation and Treatment - Late Phase
 - 1. Re-evaluation
 - a. Wounds healed and external hardware removed. If not, continue to monitor response to wound care treatment and signs of infection.
 - b. Superficial and deep scar adhesions should be evaluated through palpation and range of motion assessment to determine if previous and current scar management techniques are effective
 - 2. Wound and scar management
 - a. Same as intermediate phase. However, if no improvement, must consider changes in treatment plan.
 - b. Scar management techniques should be vigorous
 - c. Longer periods of scar and retrograde massage
 - d. Scar molds/pressure pads applied with continuous pressure garments such as coban
 - e. Ultrasound and iontophoresis using sodium chloride suggested for management of dense scar formation, but clinical efficacy has yet to be definitively established
- IV. Therapist's Evaluation and Treatment – Edema/Vascular^{4,5,7}
- A. Edema/Vascular Evaluation – Acute Phase
 - 1. Visual inspection
 - a. Subjective gross status report: slight, minimal, moderate, severe
 - b. Type of edema; pitting is common in acute stage

Chapter 27 Figures



Fig. 5. Nerve Repairs.



Fig. 6. Dressing Application.



Fig. 7. Whirlpool.



Fig. 8. Scar Massage.

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2. Circumferential measurements - use consistent landmarks to increase reliability
3. Volumeter
 - a. During the acute phase, the volumeter would not be used secondary to open wounds
 - b. If amputations are associated with injury, volumeter can be used to compare involved hand to itself on subsequent visits, not to uninvolved hand
- B. Edema/Vascular Treatment – Acute Phase
 1. Elevation (Fig. 9)
 - a. The hand should be elevated slightly above heart level at all times except in the case of vessel repairs
 - b. In the case of repaired vascular structures, the hand should be positioned at the same level as the heart to avoid stress on either the venous or arterial systems
 - c. Arm slings are generally not recommended as they place the injured hand below the level of the heart. If used, sling should place the hand above or at level of heart.
 2. Compression (after blood supply is well established)
 - a. Elastic bandage, Coban→, Isotoner→, or Jobst→ glove
 - b. Vasopneumatic compression
 - c. Compression is contraindicated with vessel repairs for the first 6 weeks post-op
 3. Active exercise
 - a. Usually limited due to pain and edema; therefore, adjunct therapy to reduce pain and edema should facilitate active motion.
 - b. May be limited due to contraindication for movement of involved structures
 4. Thermal Agents
 - a. If started prior to 8 weeks post repair, use with caution and extra insulation
 - b. Cryotherapy applied with hand positioned in elevation
 - c. Heat is not commonly used during the initial stages of acute management since not only is the area insensate, but with disruption of the lymphatic system, it cannot dissipate heat effectively, thus, causing burns. Depending on quality and quantity of edema, heat may be used in later weeks. (Fig. 10)
 5. Manual Edema Mobilization
- C. Edema/Vascular Evaluation and Treatment – Intermediate to Late Phase
 1. Re-evaluation
 - a. Continue to assess edema and note response to treatment
 - b. If no open wounds, volumeter can be used
 - c. Edema is usually less of a problem in this phase
 - d. Monitor for signs of acute inflammation due to increased therapeutic exercise, functional overuse, or vigorous exercise
 2. Edema Control
 - a. More vigorous techniques
 - b. Compression garments should not restrict functional use of hand or therapeutic exercise
 - c. Retrograde massage or manual edema mobilization
 - d. Vasopneumatic compression devices
 - e. Active exercise, especially in elevation
 3. Continue with caution for 6 weeks after vessel repairs
 4. Need for continued monitoring of color changes with compression techniques
- V. Therapist's Evaluation and Treatment – Sensibility/Nerve/Pain^{4,5,7}
 - A. Evaluation - Acute/Early Phase
 1. Sensibility
 - a. Gross Assessment – performed initially
 - b. Subjective and cursory (insensate areas noted)
 - c. Specific Assessment

- i. More appropriate after wounds heal and edema decreases
 - Semmes Weinstein sensory evaluation
 - Static or moving 2pt discrimination
 - ii. Pain and edema may alter sensibility status
 2. Pain evaluation
 - a. Numerical scale (0-10)
 - b. Visual analog pain scale
 - c. Body pain diagram
 - d. Quality of pain: sharp/dull, burning, etc.
- B. Pain Management - many thermal and electrical agents have limited use in the early phase due to precautions for sensibility and vascular compromise
 1. Thermal Agents
 - a. Heat discouraged during acute phase
 - b. Cold may provide analgesia and control edema with hand elevated above heart level
 - c. Contraindications if autonomic efferent function is impaired: poor ability to respond to tissue temperature changes
 - d. Electrical Stimulation/TENS
- C. Sensibility/Nerve/Pain Evaluation and Treatment – Intermediate to Late Phase
 1. Re-evaluation
 - a. Pain – If pain behavior exceeds expected level and timeframe post-injury, consider use of pain assessment tools. Assess response to pain control techniques. Pain problems at this stage may be related more to confounding psychological problems rather than a physiological basis.
 - b. Sensibility
 - i. At 6-8 weeks post-injury, formal sensibility examinations reveal status of nerve damage to cutaneous tissue and any signs of nerve regeneration.
 - ii. Monthly evaluations assess return of protective sensation.
 - iii. Return of protective sensation dictates the initiation of sensory re-education.
 - iv. If protective sensation is not returned, patient must be aware of potential hazards by using compensatory techniques (visual, cues from adjacent digits). Use of thermal agents is still constrained.
 2. Pain control - physical agent modalities
 - a. Heat and cold can produce an analgesic effect and may also reduce residual edema.
 - b. Thermal agents may still be contraindicated if protective sensation is not evident.
 - c. Contraindicated in repaired vessels or nerves for at least 8 weeks.
 - d. Electrical Stimulation.
 3. Sensation
 - a. Desensitization techniques
 - i. Texture
 - ii. Vibration
 - iii. Massage
 - iv. Fluidotherapy
 - v. Particle immersion
 - b. Sensory re-education
 - c. Compensatory techniques
- VI. Therapist's Evaluation and Treatment – Range of Motion/ADL^{4,5,8,9}
 - A. Evaluation – Early Phase
 1. Range of Motion Assessment
 - a. Non-involved proximal joints - shoulder, elbow, wrist, and forearm
 - b. Non-involved hand for comparison

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- c. Non-involved joints of the involved hand
 - d. Involved joints of the hand – only as permitted, depending on damage to structures that cross the joint
 2. Strength - it is rarely appropriate to evaluate strength during the initial evaluation secondary to precautions for involved structures, pain and edema
 3. ADL evaluation
 - a. Patient interview – to determine whether patient is appropriate to teach one-handed techniques
 - b. ADL checklist – to determine need for assistive devices to allow patient to maintain some level of functional independence
- B. Treatment – Early Phase
 1. ROM - Early Protected Motion
 - a. AROM/PROM to uninvolved joints (shoulder, elbow, forearm, wrist, finger) is indicated only if repaired structures of affected joints not affected (Fig. 11)
 - b. PROM and AROM to involved joints as permitted depending on structures involved. If a degloving injury occurs with flexor tendon damage, the early motion program would be established based on the surgeon's primary flexor tendon repair protocol.
 2. Rationale for Early Protected Motion (EPM) Protocol⁸
 - a. Differential glide of tendons
 - b. Movement of joints
 - c. Protection from composite motion, which may disrupt repairs
 - d. Promote enough tendon gliding without tension to prevent adhesions
 3. Early Motion Protocol for Digital Replants^{8,9}
 - a. EPM I: controlled active tenodesis
 - i. Patient actively flexes the wrist, therapist may assist – the digital joints fall into extension
 - ii. Patient actively extends the wrist to neutral – the digits fall into flexion with the assistance of gravity, and therapist applies light pressure into flexion
 - iii. Performed 4-14 days post-op
 - b. EPM II (passive intrinsic minus)
 - i. Wrist held in neutral, therapist alternates modified passive hook fist with intrinsic plus position (table tops), with PIP flexion limited to 60 degrees for 4-6 weeks
 - ii. Initiated 7-14 days post-op
 - c. EPM II (active intrinsic minus)
 - i. Same as EPM II passive phase but exercises are done actively by patient
 - ii. Therapists may assist active motion with patient (AAROM)
 - iii. Initiated 2 weeks post-op
- C. Range of Motion and ADLs– Intermediate Phase
 1. Range of Motion Considerations
 - a. Precautions governed by the restrictions of all systems
 - b. Note response to treatment
 - c. Pay particular attention to developing contractures
 - d. Cause of restricted motion (differential diagnosis) dictates course of treatment, such as therapeutic exercise and orthoses
 - i. Intrinsic tightness
 - ii. Extrinsic flexor or extensor tightness
 - iii. Oblique retinacular ligament tightness
 - iv. Joint contracture, capsule tightness
 - v. Adhesions
 - vi. Weakness
 - vii. Self limited by pain

Chapter 27 Figures



Fig. 9. Elevation.



Fig. 10. Heat Modality (Paraffin).



Fig. 11. ROM of Unaffected Digits/Joints.



Fig. 12. Dorsal Blocking Orthosis.

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2. Therapeutic exercise
 - a. Precautions for healing structures still apply
 - b. Tendon gliding exercises initiated approximately 4 weeks post-op if skeletal structures stable
 - c. Composite motion initiated for digital flexion and extension
 - d. Passive stretching exercises in opposite direction of normal action of injured tendon permitted about 6 weeks post-op
 - e. Once 4-6 weeks post-op, full PIP flexion permitted with digital replant: minimizes risk for attenuation of central slip of extensor mechanism
 - f. Initiate non-resistive functional grasp and prehension activities as soon as able to encourage normalization of movement patterns
 3. ADLs - Function and Purposeful Activity
 - a. Encourage functional independence without risk to repaired structures
 - b. Light prehension activities
 - c. Use of adaptive equipment
 - d. One-handed techniques
 4. Strengthening and Aerobic Exercise
 - a. Grip evaluation may still be contraindicated
 - b. Manual muscle testing may now be appropriate to determine extent of nerve involvement
 - c. Light resistive exercises are initiated after cleared by MD when healing structures can tolerate applied tension. Usually between 6-8 weeks post-op
 - d. Aerobic exercises used to prevent deconditioning
 - e. Begin resistive exercise of non-involved extremities in addition to proximal muscles of involved extremity as soon as medically safe
- D. Range of Motion and ADLs – Late Phase
1. Re-evaluation
 - a. There should no longer be any precautions to motion in this phase
 - b. Differential diagnosis to determine the cause of restricted motion is essential
 - c. ROM assessment continues to direct course of orthotic use and therapeutic exercise
 2. ROM Exercises and Strengthening
 - a. Passive stretching exercises to structures contributing to loss of motion
 - b. Aggressive tendon gliding and blocking exercises
 - c. Isometric resistive gripping exercise at multiple angles to enhance tendon gliding
 - d. Strengthen involved hand as tolerated. Continue strengthening, as indicated, for uninvolved joints or extremities.
 - e. Emphasis on functional strength, endurance, and dexterity
 - f. Aerobic exercise to return to work and overcome deconditioning.
 3. ADLs and Return to Work Activities
 - a. Training for specific ADL problems
 - b. Prior to discharge, a Functional Capacity Evaluation (FCE) can assess patient's ability to return to work or to establish the need for alternative work
 - c. Work simulation, conditioning
 - d. Return to work issues
 - i. Patient may not be able to return to previous job
 - ii. Vocational training
 - iii. Disability and impairment ratings
 - e. Patient may return to previous job with modifications
 - i. Modified tools
 - ii. Protective gloves
 - iii. Limitations to cold (intolerance)
 - iv. Considerations for hypersensitivity

v. Limited exposure to vibration

VII. Orthoses^{4,5,9,10}

- A. Static orthotics provide
 - 1. Rest
 - 2. Support
 - 3. Protection, allow for proper healing
 - 4. Position to prevent deformity or to minimize potential developing contractures
- B. Protected position orthosis – will vary dependent on structures repaired, precautions (quality, tension on repairs) and also what a patient can tolerate post operatively
 - 1. Wrist position neutral to slight extension
 - 2. MPs about 60-70 degrees flexion
 - 3. IPs at 0-10 degrees extension
- C. Dorsal block orthoses
 - 1. Often used with replants, flexor tendon repairs, and nerve repairs
 - 2. For full hand replant, include protection over thumb (Fig. 12)
- D. Existing orthotics should be continually re-evaluated to determine their effectiveness and if they are still indicated
- E. Static Progressive or Dynamic Orthoses
 - 1. May be initiated once healing structures have enough tensile strength to tolerate applied forces
 - 2. Often needed to address PIP flexion/extension, MP extension, and 1st web space contractures
 - 3. Apply low-load prolonged stress to tissues contributing to loss of motion
- F. Orthotics to provide support or improve functional use of hand such as anti-claw or opponens

VIII. Conclusions

- A. No specific protocols for therapeutic management of the mutilated hand
- B. Each component of the injury needs to be considered during evaluation and treatment planning
- C. Therapeutic interventions must be considered in the total picture of the complex injury
- D. Psychosocial needs can not be ignored
- E. Communication with all team members is essential
- F. Therapist must have knowledge of normal and pathologic healing of all injured tissues
- G. Reconstruction is essentially a salvage procedure to restore hand function, and, therefore, therapeutic intervention should emphasize restoration of maximum function

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Multiple Choice Questions

1. After a mutilating hand injury, which phase of healing is often prolonged by edema formation, with with slowed epithelialization of skin?
 - A. Fibroplasia
 - B. Maturation
 - C. Inflammatory
 - D. Remodeling
2. During which phase of wound healing is collagen produced at a rapid rate, resulting in many structures becoming adherent in the same scar?
 - A. Fibroplasia
 - B. Inflammatory
 - C. Maturation
 - D. Remodeling
3. During the maturation phase of wound healing, collagen lysis _____ collagen synthesis.
 - A. Exceeds
 - B. Equals
 - C. Is less than
 - D. Has no relationship to
4. Using volumetric measurements, when is it best to compare the injured hand to itself on subsequent visits rather than to the contralateral hand?
 - A. When edema is excessive
 - B. When adherent scars are present
 - C. When there is an open wound
 - D. When there is an amputation
5. Extreme caution should be used with revascularized structures or replanted digits when using whirlpool because:
 - A. Water too warm may cause increased edema
 - B. Water too warm may cause vasospasm
 - C. Water too warm may cause increased stiffness
 - D. Water too cold may cause increased edema
6. Reduction or elimination of caffeinated drinks, foods or smoking is essential for patients with _____ repairs.
 - A. Nerves
 - B. Skin
 - C. Vascular
 - D. Tendons

Multiple Choice Questions

7. For management of pitting edema in the acute phase, the hand should be elevated above the level of the heart, except in the case of:
 - A. Vessel repair
 - B. Skin grafting
 - C. K-wire placement
 - D. Nerve repair
8. When applying cryotherapy to the edematous hand in the acute phase, the hand should be:
 - A. In a dependent position
 - B. In an elevated position
 - C. On the same level as the heart
 - D. In a sling
9. Heat and cold agents are contraindicated with _____ injury for the first 8 weeks.
 - A. Skin
 - B. Tendon
 - C. Joint
 - D. Nerve
10. Rationale for early protected motion (EPM) following a mutilating injury is to:
 - A. Promote tendon glide without tension to prevent adhesions
 - B. Prevent differential glide of the tendons
 - C. Protect against movement of the hand
 - D. EPM is not permitted following a mutilating hand injury
11. In a protected position orthotic, the MP joints are best positioned in about:
 - A. 10 degrees extension
 - B. Neutral
 - C. 70 degrees of flexion
 - D. 40 degrees of flexion
12. What type of dressing is indicated for a wound with well-approximated margins with signs of healing?
 - A. Wet to dry
 - B. Moist, sterile
 - C. Sterile, non-adherent
 - D. Dry, sterile
13. For dirty wounds, which require delayed primary closure or secondary wound closure?
 - A. Dressings should be occlusive to prevent further contamination
 - B. Physician should be consulted for preference on dressing type
 - C. Wounds should not be dressed but left opened for better circulation and healing
 - D. Wound should be kept dry with use of sterile pad and gauze wrap

Multiple Choice Questions

14. For wound cleansing and debridement of superficial necrotic tissue, the best temperature for a whirlpool is:
- A. 90-95 degrees F
 - B. Greater than 95 degrees F
 - C. Less than 90 degrees F
 - D. As tolerated by the patient

**Multiple Choice Question Answer Key
Chapter 27**

1-C, 2-A, 3-B, 4-D, 5-A, 6-C, 7-A,
8-B, 9-D, 10-A, 11-C, 12-D, 13-B, 14-A

Chapter 27: Complex Traumatic Injuries

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