Scott L. Hansen, M.D.
Chief, Plastic and Reconstructive Surgery
San Francisco General Hospital
Chief, Hand and Microvascular Surgery
University of California, San Francisco

Overview

- Hand Injuries
  - Fingertip and Nail bed injuries
  - Fractures and dislocations
    - Mallet finger
    - Boxer’s fracture
  - Tendon and nerve injuries
  - Amputations

Evaluation

- History
  - Age, handedness, occupation
  - Past medical history
  - History/Mechanism of Injury
  - History of Previous injuries/treatment
  - Tetanus vaccination status

- Physical exam
  - Skin/Nail bed integrity
  - Neurologic evaluation
    - Light touch, 2-point discrimination
  - Capillary refill, pulse
  - Flexor, extensor tendon function
  - Ligaments
  - Hand/Forearm compartment evaluation

- X-ray
  - Normal bone?
  - Bone quality
  - Bone lesion
  - Fracture pattern
  - Fracture alignment

- Evaluation - X-ray

- 6 Million ER visits
- 12 million office visits
- 90 million days restricted activity
- 16 million days lost
- 10 billion dollars
• Fingertip - distal to tendon insertions
• Volar pulp anchor to bone by fibrous septae
  – Grayson’s
  – Clelland’s
• Digital arteries arborize
• Digital nerves volar
• End organ touch
  – Pacinian, Meissners,

• Advantage
  – pulls innervated pulp into wound
• Disadvantage
  – duration of healing
• Consider for small wounds <1 cm,
  – distal, volar, without bone
• Small dressing

• Dorsal fingertip
• Perionychium = NB + paronychium
• Paronychium
• Eponychium

• Disadvantage - functional & cosmetic
• Advantage - minimal healing time
• Consider for manual laborer, elderly
• Complication
  – Hook nail
  – Neuroma

• Preserve useful sensation
• Maximum functional length
• Prevent joint contractures
• No donor disfigurement of function loss
• Satisfactory appearance

• Considered for children < 6 yo
• Discouraged for adults
• Nail bed most common hand injury
  – Long > Ring > Index > Small > Thumb
• Severity of injury to nail bed frequently underestimated
• Smooth nail bed essential for normal regrowth
• Loss of nail bed integrity = permanent deformity

Nail Function

• Specialized epidermal structure
  – Fingertip protection
  – Picking up small objects
  – Defense
  – Tactile sensation
  – Peripheral circulation
  – Cosmetic

Anatomy

Entire fingernail unit = Perionychium
Nail plate & bed
Paronychium- lat. nail fold
Lunula (distal extent of GM)
Eponychium- prox. nail fold

Management

• History and Physical Exam
  – Age, sex, occupation, handedness, mechanism, associated injuries
• X-Ray: Distal phalanx fracture?
  – 50%
• Tetanus status
• Anesthesia
  – Digital block
  – Regional block
  – General anesthesia (children, complex injury, multiple finger, severe contamination)

Injury Classification

• The greatest determinant of nail restoration is the nature of the injury to the germinal and sterile matrix components.
• Injuries to the germinal matrix have the most deleterious effects on the appearance of the nail.
• Classification assists in developing an appropriate treatment plan, permits predicting the outcome of treatment, and makes assessment of results easier.
**Germinal Matrix Injury**

- **G I:** Small subungual hematoma (<25%)
- **G II:** Germinal matrix laceration, large subungual hematoma (50%)
- **G III:** Germinal matrix laceration and fracture
- **G IV:** Germinal matrix fragmentation
- **G V:** Germinal matrix avulsion

Van Beek et al, 1990

**Management**

- < 25% of nail bed → drain (sterile technique)
- 25-50% germinal matrix → remove nail & evaluate nail bed
- Current thought:
  - >50% remove nail

**Sterile Matrix Injury**

- **S I:** Small nail hematoma (<50%)
- **S II:** Sterile matrix laceration, large subungual hematoma (>50%)
- **S III:** Sterile matrix laceration, tuft Fx
- **S IV:** Sterile matrix fragmentation
- **S V:** Sterile matrix avulsion

Van Beek et al, 1990

**Management**

- Simon and Wolgin 1987
- Seaberg et al, 1991
- Rosser and Gellman, 1999
- Conclusions: Intact nail and nail margins → leave nail in place and drain

**Subungual Hematoma**

- < 25% of nail bed → drain (sterile technique)
- 25-50% germinal matrix → remove nail & evaluate nail bed
- Current thought:
  - >50% remove nail

**Management**

- Small hematoma associated with small break in the underlying matrix

**Management**

- Large hematoma (>50%) and significant nail bed injury
Management

- Necessary to assess underlying nail bed
- Method varies
  - Freer elevator (Kutz)
  - Dental spatula
  - Iris scissors
  - Straight mosquito

- Place hole to allow drainage
- Nail or substitute used to:
  - Protect repair
  - Act as a splint for tuft Fx
  - Prevent scar between nail fold and nail bed

50% of nail bed injuries have associated fx
- K-wire fixation
- Irregular distal phalanx = nail deformity

Germinal matrix should be re-approximated under nail fold, use horizontal mattress 7-0 chromic.

Management-Type II

Meticulous approximation with 7-0 absorbable suture.
*minimal debridement

*Must maintain (stent) nail fold with nail, non-adherent gauze, metal foil or silicon sheet.

- Severe crush, multiple lacerations
- Amputation of portions or all of nail matrix

- Recover nail bed from avulsed nail and use as a graft
  - Can place back as one unit if intact
  - Local flap coverage vs. free nail graft
  - STSG

- Linear avulsion of the sterile and germinal matrices
- Bipedicle flap (if < 1/3 width of nail)

- Wide defect of germinal and sterile matrix
- Distally-based flap closure

- Zone 1 Injury
  Loss of active DIP extension
  Mallet Finger Subtypes
  - Tendinous
  - Bony

- Mallet finger - Doyle Classification
  - Type I: Closed, bony or non-bony
  - Type II: Open
  - Type III: Open with loss of skin, sub Q and tendon
  - Type IV
    - A: Pediatric transepiphyseal fracture
    - B: 20-50\% articular fracture, hyperflexion
    - C: >50\% articular fracture, hyperextension
• Mallet finger - Wehbe & Schneider Classification
  – Type I: No subluxation
  – Type II: Joint subluxation
  – Type III: Physis/epiphysis fracture
  – Subtypes
    • A: Less than 1/3 articular involvement
    • B: 1/3-2/3 articular involvement
    • C: More then 2/3 involvement

• Mallet finger - Surgical indications
  – Open injuries – laceration
  – Large bony fragment
    • Controversial
    • > 50% of joint surface involved
    • Subluxation of DIP joint
  – Patients unable to comply with splinting protocol (health professionals?)

• Closed Zone 1 - Tendinous Mallet Finger
  – Full time extension splinting for 6-8 weeks
    • PIP joint mobilization
    • Dorsal Splints
    • Better extension but more skin irritation
  – Volar splints
    • Less effective but fewer skin complications

• Operative Treatment
  – Open injuries
    • I&D, tendon repair (+/- DIP pinning to take tension off repair)
    • May include skin in repair (tenodermadesis)
    • May require soft tissue coverage/tendon reconstruction in degloving injuries
  – Bony mallet
    • ORIF with wires/mini-screws (+/- DIP pinning)
    • Extension block pinning
  – Patients unable to comply with splint
    • Buried transarticular wire

• Closed Zone 1 – Bony Mallet Finger
  – Generally, avulsion fractures of less than 50% of the articular surface are stable injuries.
  – An avulsion with volar subluxation of the distal phalanx represents an unstable injury.

• Occur when clenched MCP joint strikes a solid object
• Angulates with apex dorsal
  – Communion of volar MC neck
  – Maintains flexed MC head
• Called “Boxer’s Fracture”
Metacarpal Neck Fractures

- Usually RF or SF
- Nonunion virtually never occurs
  - Malunion may be a problem
- Findings
  - Loss of prominence of MC head
  - Diminished ROM
  - Rotatory misalignment
- Controversy regarding optimum treatment
  - Some accept large degrees of angulation (especially RF and SF)
    - 30-40 degrees RF, 50-60 degrees SF
  - Almost universal agreement that angulation over 10-15 degrees at IF, MF require treatment

- Reduction indicated for pseudoclawing (MCP hyperextension and PIP flexion)
- Intervention depends on metacarpal, presence of rotational deformity, and degree of angulation
- Rough guidelines: IF/MF > 10-15, RF > 30-40, SF > 40-50
- Operative intervention if cannot hold closed reduction

Metacarpal Neck Fractures: Anatomical Basis for Treatment

- 5th CMC joint has 30 degrees of movement
- 4th CMC joint has 20 degrees of movement
- 2nd & 3rd CMC joints have little movement

- Immobilization in gutter splint for approx. 2 weeks
- Protected splinting and ROM
- Buddy tape to control malrotation
- Unrestricted activity in 4-6 weeks

Metacarpal Neck Fractures: Treatment Considerations

- Reduction indicated for pseudoclawing (MCP hyperextension and PIP flexion)
- Intervention depends on metacarpal, presence of rotational deformity, and degree of angulation
- Rough guidelines: IF/MF > 10-15, RF > 30-40, SF > 40-50
- Operative intervention if cannot hold closed reduction

- Controversy regarding optimum treatment
  - Some accept large degrees of angulation (especially RF and SF)
    - 30-40 degrees RF, 50-60 degrees SF
  - Almost universal agreement that angulation over 10-15 degrees at IF, MF require treatment

- Immobilization in gutter splint for approx. 2 weeks
- Protected splinting and ROM
- Buddy tape to control malrotation
- Unrestricted activity in 4-6 weeks

Metacarpal Neck Fractures: Jahss Maneuver

- Flexing MCP to 90 degrees relaxes deforming intrinsics and tightens collateral ligaments, allowing proximal phalanx to exert pressure on MC head

- Immobilization in gutter splint for approx. 2 weeks
- Protected splinting and ROM
- Buddy tape to control malrotation
- Unrestricted activity in 4-6 weeks

Metacarpal Neck Fractures: Jahss Maneuver

- Flexing MCP to 90 degrees relaxes deforming intrinsics and tightens collateral ligaments, allowing proximal phalanx to exert pressure on MC head

- Immobilization in gutter splint for approx. 2 weeks
- Protected splinting and ROM
- Buddy tape to control malrotation
- Unrestricted activity in 4-6 weeks
• History
• Physical Examination
• Surgical Repair
• Rehabilitation

Diagnosis of Flexor Injury

• Normal cascade
• Independent testing of FDS & FDP
• Passive tenodesis test
• Forearm compression test

• History
  – Age, Hand Dominance, Occupation, PMH
• Mechanism of Injury
  – Sharp transection vs. crushing vs. avulsion
• Physical Exam
  – Associated injuries
• X-rays

Evaluation for Replication

• History
  – Age, Hand Dominance, Occupation, PMH
• Mechanism of Injury
  – Sharp transection vs. crushing vs. avulsion
• Physical Exam
  – Associated injuries
• X-rays

Hansen 2010

Criteria for Replication: Upper Extremity

• Thumb
• Children
• Single digit distal to FDS insertion
  – Controversial
• Multiple digits
• Partial hand
• Wrist and forearm
• Elbow and proximal arm

Hansen 2010

Criteria against Replication: Upper Extremity

• Severe concomitant injuries
• Severely crushed or mangled
• Multi-level amputations
• Significant co-morbidities
• Prolonged warm ischemia time
• Mentally unstable/ self-mutilation
• Single finger proximal to FDS insertion

• Timing of repair
  – Primary repair: within 24 hours of injury
  – Delayed primary repair: 24 hrs to 2 wks
  – Similar results for primary and delayed primary
• Splint to prevent proximal retraction
Types of Injuries

- Sharp “guillotine” type injuries
  - Power saw injuries most common
- Avulsion injuries
  - Ring avulsion
- Crushing injuries

Preserving the Amputated Part

- Gently cleanse foreign material
- Wrap in moistened sterile gauze
- Place in sterile container
- Place container on ice
- Avoid freezing the part
- Part explored on the back table to assess severity of injury

Viability of Amputated Part

- Fingers have greater tolerance to ischemia than parts containing muscle
- Fingers
  - Warm ischemia: 6-8 hours
  - Cold ischemia: up to 48 hours
- More proximal amputations (muscle mass)
  - Warm ischemia: 6 hours maximum
  - Cold ischemia: 12 hours maximum