IC21-L: Management of Pediatric Hand and Finger Fractures

Moderator(s): Lindley B. Wall, MD

Faculty: Andrea S. Bauer, MD, Mary Claire Manske, MD, and Apurva S. Shah, MD, MBA

Session Handouts
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IC21-L
Management of Pediatric Hand and Finger Fractures

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Epidemiology and Physical Exam of Pediatric Hand and Finger Fractures

Mary Claire Manske, MD

Speaker has no relevant financial relationships with commercial interest to disclose.
Introduction

- Hand is the most commonly injured part of a child’s body
  - 1/3 of all pediatric ER visits
  - 2/3 of all childhood fractures occur in the upper extremity
- Children’s hands are vulnerable to injury
- Increasing incidence
- Most can be treated non-operatively
  - Key is to recognize bad actors

Epidemiology

- Pediatric fractures presenting to the Emergency Department in the U.S.
  - Forearm
  - Finger
  - Wrist
  - Shoulder
  - Hand

- Association of Hand Trauma with Age and Sex
  - Bimodal: Toddlers and adolescents
  - Toddlers:
    - Soft tissue injuries
    - Crush mechanism
    - Household accidents
    - Male = Female
  - Adolescents
    - Fractures
    - Sports injuries
    - Male > Female
- Association between age and fracture

Epidemiology
- Hand fractures by sex and age

Epidemiology
- Fracture Location
  - Border digits > Central digits
  - Phalanges > Metacarpals > Carpus
Epidemiology

- Pediatric hand fractures commonly referred to a hand specialist
  - 32% - 100%

  Common reasons for referral
  - Fracture displacement
  - Loss of joint congruity
  - Fracture instability

- Injury may not be as billed
  - ~10% incorrect diagnosis/misdiagnosis rate
  - Misinterpretation of physis/epiphyseal, multiple fractures, inadequate/wrong x-rays

Surgical intervention in 2-10%

- Most extra-articular fractures treated with closed reduction ± internal fixation
- Intra-articular fractures more likely treated with open reduction, internal stabilization

Kreutz-Rodriguez et al Hand, 2020

Physical Examination
Examining a child’s injured hand can be difficult

- Can't communicate what’s wrong
- Can’t answer difficult questions
- Won’t follow commands
- Afraid/anxious/in pain

**Physical Examination**

Comprehensive Assessment
- Skin: abrasions, lacerations, threatened skin
- Bones and joint: alignment/deformity, tenderness, motion
- Neurovascular status: sensation, strength, perfusion

My Approach
- Inspection
- Active tasks/Cooperation
- Passive
- Things that may hurt

**Physical Examination**

General tips
- Have someone else be the bad cop
- Engage parents to help
- Tell the kid what you are going to do
- Demonstrate on yourself, parent, or child's other hand
- Save things that hurt until the end
Physical Examination

Other tips

- Child Development
  - Stranger anxiety
  - How to ask questions
  - Make exam a game
- Pick your battles
- Distraction techniques/Child Life

Physical Examination

Inspection

- Swelling
- Ecchymosis
- Skin lesions
- Clinical alignment/deformity
- Digital cascade
- Compare to contralateral hand

Physical Examination

Inspection

- Neurovascular status

- Sensory denervation
  - Dry skin/loss of sweat patterns

- Color, turgor, temperature
  - Pale, flat, cool: arterial disruption
  - Purple, dusky, congested: venous congestion
Physical Examination

Active Participation
- Use stickers or a small toy
- Evaluate motion
- Watch the child play
- Spy on them while taking a history

Active Cooperation
- Use simple commands, goal oriented tasks
- Fun tasks
- Tell child only have to do it once. “1...2...3...Go”

Passive examination
- Explain to child what you are going to do
- Tenodesis to assess cascade of fingers
- Wrinkle test to assess sensory nerves
• Things that may hurt

• Explain what you are going to do
• Give choices if appropriate
• Distraction techniques/Child Life

Summary

• Pediatric hand and finger injuries are common
  - adolescents: sports injuries, fractures
  - toddlers: household injuries, soft tissue injuries

• Often non-operative treatment is appropriate

• Tips for physical exam
  - earn child’s trust
  - toys/stickers
  - explain in terms they can understand

Thanks and Good Luck!
Metacarpal Fractures in Children
Andrea S. Bauer, MD
Assistant Professor of Orthopaedic Surgery
Boston Children's Hospital

DISCLOSURES
Andrea S. Bauer, MD
Speaker has no relevant financial relationships with commercial interest to disclose.

Epidemiology
- 30% of pediatric hand fractures
- Most common hand fracture in 13- to 16-year-olds

Classify and treat by location:
- Head
- Neck
- Shaft
- Base
Metacarpal head fractures

- Often missed
  - Don’t be afraid to get advanced imaging
- Open reduction & pinning / headless screws
  - Can lead to AVN
  - Follow long term
Metacarpal neck fractures

- Common teenage injury
  - Sports
  - Punching
- Acceptable angulation
  - 10/20/30/40 (index-small fingers)
  - Some studies quote up to 70 degrees “acceptable” for small metacarpal neck
- Why is it unacceptable?
  - Extensor lag
  - Prominence in the palm

Jahss maneuver for closed reduction (more on this later)

Metacarpal shaft fractures

- Central rays stabilized by intermetacarpal ligaments
  - Generally can be treated nonoperatively (mitten cast)
- Acceptable angulation is HALF that of neck fractures
- Rotational malalignment is common – check tenodesis!

Indications for surgery – neck & shaft fxs

- If you can’t get “acceptable alignment”
  - Rotation is never acceptable
- Open fractures
- Multiple fractures
Surgical options - neck & shaft fxs

Lots of options in kids
- Lag screws alone
- Plate & screws
- IM nail/screw
- Multiple pin configurations

Metacarpal base fractures
- Rare in truly “pediatric” patients
- Perhaps higher chance of nonoperative management?
Does Closed Reduction and Immobilization of Pediatric Metacarpal Fractures Result in an Improvement in Fracture Angulation?

Stella J. Lee MD, Hannah Merrison, Kathryn A. Williams MS, Carley B. Vuillermin MBBS MPH, Andrea S. Bauer MD

Retrospective Cohort Study

Level 1 Pediatric Trauma Center
- Emergency Department and Clinic
Patients treated Jan 2011 – Sept 2016
- Closed reduction and immobilization
- 2nd to 5th Metacarpal Neck and Shaft Fractures
18 years and younger
Exclusion criteria
- Open fractures
- Multiple metacarpal fractures
- Reduction performed at outside facility
- Missing or inadequate post-reduction radiographs

Lateral Fracture Angulation

Medullary canal method
- Leung et al, JHS 2002
- Validated with inter- and intra-rater testing

Time points
- Immediate
- Initial follow up (2-14d)
- Healed (21-35d)

Clinically significant improvement = 10 degrees
Study Cohort

91 Patients
Average age 15 years
- Range 9-18y
92% Male
Metacarpal skeletal maturity
- Physis open 48%
Anatomic location
- 5th metacarpal 87%
- Neck 2/3rds
Mechanism
- Punch 64%
- Sports 23%
- Fall 4%

Lateral Angulation Measurements

<table>
<thead>
<tr>
<th>Time Point</th>
<th>Angle (sd)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Injury</td>
<td>40.7 (10.7)</td>
<td>7-66</td>
</tr>
<tr>
<td>Early Follow up (2-14d)</td>
<td>33.2 (9.6)</td>
<td>3-56</td>
</tr>
<tr>
<td>Healed (21-35d)</td>
<td>35.3 (11)</td>
<td>-3 - 57</td>
</tr>
</tbody>
</table>

Lateral Angulation Difference from Pre-reduction

<table>
<thead>
<tr>
<th>Time Point</th>
<th>Angle (sd)</th>
<th>p-value Mean ≠ 0</th>
<th>p-value Equivalence Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate</td>
<td>8.3 (10.2)</td>
<td>&lt;0.001</td>
<td>0.123</td>
</tr>
<tr>
<td>Early Follow up (2-14d)</td>
<td>8.9 (10.2)</td>
<td>&lt;0.001</td>
<td>0.198</td>
</tr>
<tr>
<td>Healed (21-35d)</td>
<td>5.8 (12.4)</td>
<td>&lt;0.001</td>
<td>0.003</td>
</tr>
</tbody>
</table>
Subgroup Analyses

Open vs Closed physe
Neck vs Shaft
Extension vs intrinsic-plus position

No significant mean differences for all difference levels p>0.05

Fracture angulation greater than or less than 50 degrees

Injury angle >=50 has significantly higher mean reductions than
Injury angle <50 for all difference levels

Conclusions

Retrospective study

Modest improvements in lateral fracture angulation

Closed reduction of pediatric metacarpal fractures results in a clinically
insignificant improvement in lateral fracture angulation

Maybe limited utility in the treatment of fractures with angulation greater
than 50 degrees

Summary

• Metacarpal fractures are common in teenagers
• Most can be treated nonoperatively

• Pitfalls to watch for:
  – Metacarpal head fractures ⇒ get advanced imaging and follow long term
  – Always check tenodesis ⇒ no rotation is acceptable, even in a kid
  – Although we can accept a lot of angulation in 5th MC neck, the same rules
don’t apply for more radial MCs or for shaft fxs
  – Consider whether a closed reduction is “worth it” – if you wouldn’t operate
    anyway, maybe skip it?
Phalangeal Fractures in Children
Operative vs. Nonoperative Management & Remodeling Potential

Apurva S. Shah, MD MBA
Assistant Professor of Orthopaedic Surgery
Director of Orthopaedic Research
Director of the Brachial Plexus Program

DISCLOSURES

Aprüfva S. Shah, MD

Speaker has no relevant financial relationship to disclose.
Hand Fractures
Most commonly injured part of child
Crush injury to fingertip most common hand injury in toddlers & young children (46% doors & windows)
Yorlets et al. Hand 2017

Treatment
Vast majority → Nonoperative
Operative treatment
- Malrotation or deviation
- Unstable fractures
- Displaced phalangeal neck fractures
- Unicondylar fractures
- Displaced intraarticular fractures
- Seymour fractures

Finger Proximal Phalanx
Can be difficult to visualize on radiographs
Often Salter-Harris II, but can be juxaphyseal
Will remodel in young children
Can be treated with closed reduction, taping and casting
Percutaneous pinning acceptable option if residual deviation or central digit

*Most Salter-Harris II proximal phalanx fractures need closed reduction without pinning
Phalangeal Shaft Fracture
Often unstable and generally require operative treatment
Younger children → Closed reduction and pinning
Older children → Treat similar to adults

Phalangeal Neck Fracture
Fracture extends and translates dorsally
Common toddler crush injury
Distal fragment may appear small (unossified)
Displaced fractures result in loss of IP flexion
Loss of subcondylar fossa
May remodel a little even in older patients
Cornwell & Waters 2004
Phalangeal Neck Fracture

Radiographs
True lateral required to assess the amount of dorsal displacement
Fragment appears small due to cartilaginous articular surface in young child

Phalangeal Neck Fracture

Treatment
Near anatomic reduction to restore the subchondral recess and deep flexion

Timely closed reduction & pinning
Full recovery of ROM expected

Impending malunions can be treated with intrafocal pin osteoclasis
ORIF should be avoided, need to preserve vascularity through collateral ligament (high risk of AVN)
Phalangeal Neck Fracture

Subacute: use intrafocal pin to lever reduction
Chronic: subcondylar fossa reconstruction

Phalangeal Neck Remodeling

5 yo boy with middle finger proximal phalangeal neck fracture
Cornwall A Waters JHS 2004

Phalangeal Inter-condylar Fracture

Diagnosis
- Often present late as “jammed fingers”
- Double shadow appearance at condyle
- Rotational deformity often present
- True orthogonal films required

Treatment
- Nondisplaced fractures can be treated closed
- Displaced fractures require timely closed reduction and pinning with minimum 2 pins per fragment if possible
- ORIF with great care to preserve vascularity, since high risk of AVN with open treatment (preserve collaterals for blood supply)
## Mallet Equivalent Injury
Salter-Harris III or IV injury
Most can be splinted continuously x 6 weeks
Irreducible need to be reduced (preferably closed)
- Extension block pinning (Hofmeister et al JHS 2003)
- Mean ROM 4-77° flexion
- Re-establish extensor tension
- Restore joint congruity

## Phalanx Fractures
Beware of the Seymour fracture!
- Physeal fracture
- Open (nail avulsed)

## Phalanx Fractures
Beware of the Seymour fracture!
- Physeal fracture
- Open (Nail avulsed)
- Torn nailbed interposed
Phalanx Fractures
Beware of the Seymour fracture! Through debridement to avoid osteomyelitis, deformity, growth arrest

Seymour Fracture

Take Home Points
1. Management influenced by remodeling potential
2. Most phalangeal fractures treated non-operatively, but beware of minimally displaced phalangeal neck fractures
3. Seymour fractures need early I&D
Objectives

- Understand unique thumb anatomy
- Discuss fractures of the thumb ray
- Discuss treatment for thumb fractures
- Post-op protocol
**Background**
- Young
- Exploring the surrounding world
- Adolesences
- Sports/Recreational activities
- Thumb ray is exposed and used for grip

**Anatomy**
- Similar to a finger without a metacarpal
- Physis is located proximally in distal, middle/proximal phalanx, and metacarpal
- Pseudoepiphysis* – distal and does not grow
- Double epiphysis – active growth plates proximal and distal
- Contralateral images if questionable

**Anatomy**
- Tendon insertions
- Determine fracture displacement
- Extensor Pollicis Longus – inserts onto the epiphysis of the distal phalanx
- Abductor Pollicis Longus – Epiphysis and metaphysis of the metacarpal
- Adductor Pollicis – Proximal phalanx and extensor tendon through the adductor aponeurosis
- FPL – inserts into the metadiaphyseal region of the distal phalanx
- FPB – inserts into the metadiaphyseal region of the proximal phalanx
Anatomy

- Collateral ligaments
- MPJ collaterals insert into the epiphyseal region of the proximal phalanx
- SHIII injuries
- In comparison - PIPJ collaterals insert into the metadiaphyseal region
- SHII injuries base of proximal phalanx

Xray imaging

- True lateral of thumb
- Pronate hand 15-35 degrees
- Remember pseudoepiphysis
- Sesamoids
- Compare to contralateral side if needed

Distal Phalanx

- Similar to lesser digits
- Alignment and angulation – CRPP
- Low threshold to pin across IPJ
- * Beware the Seymour – can happen in thumb also
Proximal Phalanx

- Condylar fractures
  - Need anatomic alignment
  - Low threshold for open reduction

- Subcondylar fractures
  - Limited stability – hard to hold in cast
  - Non-displaced watch closely
  - Displaced - reduce and pin stabilization

Proximal Phalanx

- Base Fracture
  - Salter Harris II or juxaphyseal
  - Don’t treat based on x-rays
  - Mild angulation tolerated
  - Confirm with family*

Proximal Phalanx

- Base Fracture
  - Increased angulation
  - Closed reduction and pinning
Proximal Phalanx

- Salter Harris III Base fx - Ulnar Avulsion
- Skier/Gamekeeper's thumb
- Equivalent to Adult UCL injury/avulsion.
- >11yo
- Need anatomic alignment – fix if displaced (>1.5mm or rotated)
- Fragment larger and more palmar in size than seen radiographically
- Open reduction and pin/screw fixation

Proximal Phalanx

- Ligament avulsions can happen in kids...
- 11yo Male
- Curvilinear ulnar incision
- Repair with suture anchor or bones tunnels.

Thumb Metacarpal Base

- Extra-articular
  - Volar flexion, apex dorsal
  - Can laterally displace
  - 30 degrees angulation***
  - Clinical appearance and age
  - Often shaft displacement
  - Periosteum entrapped and makes reduction difficult
  - Heal reliably
Thumb Metacarpal Base

- Intra-articular/Bennet
  - Displaced proximal and dorsal
- Need congruent joint
- Attempt closed reduction
  - Traction, abd head, pronation
- Low threshold for open reduction
  - Volar approach
  - Pins or screw fixation
  - Pin across CMC if needed

Post-op/Fracture healing

- Cast or pins for 4 weeks
- Protective ROM and custom hand-based brace for 3 weeks
- Brace for few additional weeks for sports if needed
- UCL avulsion
- Thumb MPJ taping for sports after brace for 3 weeks

Thank you
Pediatric Carpal fractures

- Uncommon injuries
- Adolescents >> Children
  - Carpal ossification
  - Mechanism of injury
- Most common are scaphoid >> capitate >> other carpal bones

DISCLOSURES

Mary Claire Manske, MD

Speaker has no relevant financial relationships with commercial interest to disclose.
Scaphoid Fractures

Pediatric Scaphoid Fractures

- 11/100,000 per year
- ~3% pediatric hand/wrist fracture
- Concomitant injury

Scaphoid Fractures

Pediatric Scaphoid Fractures

- Adolescent injury
  - ossific nucleus 5 yo, ossified 13-18 yo
  - rare in children < 10 yo
- Changing fracture patterns
  - distal pole (historical)
  - waist and proximal pole (current)

Scaphoid Fractures

Pediatric Scaphoid Fractures

- Occult
- Acute
- Nonunion
Scaphoid Fractures

Occult Scaphoid Fractures
- Clinical evidence of fracture on initial evaluation
  - tenderness of anatomic snuffbox—not specific
  - x-rays negative for fracture
- 30% clinically suspected scaphoid fractures
- Clinical signs associated with occult scaphoid fracture
  - tenderness of distal tubercle volarly
  - axial compression of thumb
  - pain with radial deviation, wrist ROM
  - pain with active wrist ROM

Diagnosis
- X-rays 2 weeks post injury vs MRI

Treatment
- Immobilization until radiographic union or clinically asymptomatic
- ~4-6 weeks

Acute Scaphoid Fractures
- <6 weeks from injury
- Fall on hyperextended, pronated wrist
- Changing fracture patterns
  - increasing incidence waist and proximal pole fx
- Mechanism of injury changing
  - increased sports participation
  - extreme sports
  - increasing BMI
Scaphoid Fractures

Acute Scaphoid Fractures

- Clinical exam
  - anatomic snuffbox, distal tubercle, axial grind
  - scaphoid Watson shift test
  - wrist, digit, forearm ROM

- X-rays: PA, lateral, ulnar deviation/navicular view
- CT scan: if needed
  - evaluate displacement, assess carpal alignment, plan surgical approach

- Treatment determined by fracture location and displacement

Scaphoid Fractures

Non-Operative Treatment

- Indications
  - non-displaced distal pole and waist fractures
  - proximal pole fractures?

- Cast immobilization
  - Long arm cast vs Short arm cast vs thumb spica
  - immobilization time proximal pole > waist > distal pole
  - x-rays q 4-6 weeks, CT at 3 months if no radiographic healing or symptomatic

- Outcomes
  - 90-99% union rates in non-displaced fractures treated with prompt immobilization

Scaphoid Fractures

Operative treatment

- Indications
  - displaced fractures
  - consider for proximal pole fractures

- Open vs percutaneous reduction and internal fixation

- Dorsal vs Volar approach

- Bone grafting (distal radius, iliac crest)
Scaphoid Fractures

Operative treatment

- Post-operative care
  - Short arm thumb spica cast
  - q 6 week x-rays, CT scan at 3 months
  - Consider bone stimulator if <50% bony bridging on CT scan at 3 months

- Outcomes
  - 90% union following surgery
  - Increased time to union: open physes, displaced fx, screw type, bone graft needed

Scaphoid Fractures

Scaphoid Nonunion

- <1% nonunion of acute fx with prompt management
- Referral centers: 1/3 of pediatric scaphoid fractures present as nonunions
- Factors associated with nonunion
  - Displacement
  - Proximal pole
  - Chronicity
  - Delayed treatment >4 weeks
- Chronic fracture (>6 weeks old) less likely to heal with casting alone
  - 23% union rate
  - Chronic displaced proximal pole and waist <2%
- Natural history of pediatric scaphoid nonunions is not well understood

Scaphoid Fractures

Scaphoid Nonunion

- X-rays and CT scan

- Treatment is surgical
  - Open reduction (dorsal or volar approach)
  - Bone autograft (distal radius, iliac crest) vs vascularized
  - Internal fixation—compression screw/plate

- Outcomes
  - High union rates (>90%) with or without grafting
  - Improved ROM and strength
  - Complication rate low: iliac crest donor site pain, infection

Scaphoid Fractures

Scaphoid Nonunion

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  - Complication rate low: iliac crest donor site pain, infection
Summary

- Pediatric carpal injuries are uncommon, scaphoid most frequent
- Adolescent injury, adult fracture patterns
- Non-displaced, acute scaphoid fracture usually do well with prompt non-operative management
- Consider operative management for proximal pole, displaced fractures, or >6 weeks old

Selected References


FOCUS
OCtober 1-3, 2020 • VIRTUAL ANNUAL MEETING

Hand Fracture Cases
Moderator: Lindsey B. Wall, MD MSc

75TH ANNUAL MEETING OF THE ASSH
Lindley B. Wall, MD

Speaker has no relevant financial relationships with commercial interest to disclose.

Case 1

13yo F sustained Right small finger injury when sliding into base playing softball 1 week ago.
Approach?
- CR and casting, buddy tape
- Operative fixation
- Open versus closed
- Fixation technique

Post-op protocol?
Case 2

- 12yo M with a ring finger injury 5 months ago. Continued deformity and mild pain intermittently.
Approach

- Non-operative
- Surgical Treatment?
- Approach
- Considerations
- Fixation
Case 3

- 17yo Female presents with finger pain and swelling after “jamming” it 2 weeks ago.
Approach

• Indications?
• Splinting?
• Surgical approach?

Post-op protocol?
Case 4

- 8yo male sustained traumatic injury to ring finger while playing football 3 days ago. Seen at Urgent Care and then followed up for care.
Approach

- 3 days out...
- Timing:
  - Elective vs Immediate
  - Surgical Approach
Case 5

- 14-year-old male who presented with an injury to his right thumb which occurred while playing football when he tried to catch the ball.
Approach

- Indications for operative fixation
  - Size?
  - Rotation?
  - Displacement amount?

- Fixation technique
  - Closed vs Open?
  - Pins or screws

Post-op protocol?
Thank you

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