BASIC PRINCIPLES OF HAND TRAUMA: ARE CHILDREN DIFFERENT?

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EPIDEMIOLOGY

• HAND FRACTURES MAKE UP 2.3% OF ER VISITS
• INCIDENCE VARIES WITH AGE
  • LOW IN TODDLERS
  • INCREASES WITH AGE (20 FOLD INCREASE AFTER THE AGE OF 10)
• BOYS HAVE MORE FRACTURES THAN GIRLS
• PHALANGEAL FRACTURES MORE COMMON 9-12 YEARS OF AGE
• METACARPAL FRACTURES MORE COMMON IN OLDER ADOLESCENTS
SPECIAL PEDIATRIC CONCERNS

• PHYSIS

• REMODELLING

• HEALING POTENTIAL
PHYSIS

• PHYSIS IS UNMINERALIZED – WEAKER THAN THE SURROUNDING BONE

• PARTICULARLY VULNERABLE TO SHEAR FORCES (STRESSING THE CHONDROCYTES IN THE ZONE OF PROLIFERATION)

• MULTIPLE ATTEMPTS AT REDUCTION ARE DISCOURAGED
  • CAN CRUSH AND DISRUPT THE LAYERED ORDER OF THE PHYSIS

• PHYSEAL ARREST - CAN LEAD TO ANGULAR DEFORMITY, JOINT DISRUPTION, MALALIGNMENT
REMODELING

- Can correct for substantial initial fracture displacement
- Occurs most reliably in the plane of motion of the joint
  - Flexion/Extension
- Less chance of remodelling in the coronal plane
- Does not correct malrotation
HEALING POTENTIAL

• ROBUST PERIOSTEUM
  • HELPS WITH FRACTURE HEALING
  • HELPS WITH STABILITY OF FRACTURE (ESPECIALLY IF MINIMALLY DISPLACED)
  • POWERFUL TOOL FOR REDUCTION – “HINGE” TO LEVER THE DISTAL SEGMENT ON THE PROXIMAL TO ATTAIN ALIGNMENT

• OFTEN DECREASED TIME TO HEALING COMPARED WITH EQUIVALENT ADULT FRACTURES

• ALLOW FOR MOST FRACTURES TO BE TREATED WITH CLOSED REDUCTION AND PINNING
DISTAL TUFT FRACTURES

• CRUSH INJURIES
• TODDLER AND PRESCHOOL
• 80% OF HAND FRACTURES IN THIS AGE GROUP
• COMBINATION OF SOFT TISSUE LACERATIONS, NAIL BED INJURIES, DISTAL PHALANGEAL FRACTURES
Six-year-old boy with middle and ring fingertip crush injury and a closed subungal hematoma on the ring finger. The fractures persisted on radiograph 5 months after injury.
DISTAL TUFT FRACTURES

• TREATMENT
  • IRRIGATION AND DEBRIDEMENT
  • IMMobilization – CLAMSHELL TYPE PLASTIC SPLINT (2-3 WEEKS)
  • ? ANTIBIOTICS – GIVEN IN MOST CASES, ALTHOUGH EVIDENCE IN ADULTS DOES NOT SUPPORT THE USE OF ROUTINE ANTIBIOTICS
  • NONUNION IS RARE
  • MAY TAKE UP TO 6 MONTHS FOR RADIOGRAPHS TO SHOW UNION
SEYMOUR FRACTURES

• OPEN FRACTURE OF THE DISTAL PHALANX
• PROXIMAL EDGE OF THE NAIL PLATE SITS ON TOP OF THE EPONYCHIAL FOLD
• NAIL APPEARS “TOO LONG”
• OFTEN OVERLOOKED
Innocuous clinical presentation of a Seymour fracture with an open physeal fracture identified on true lateral radiograph. Note that the lunula appears much larger than any of the other nails, indicating the nail is avulsed from the nail bed and sitting...

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Pediatric Hand Fractures


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SEYMOUR FRACTURES

- OLDER CHILDREN AND ADOLESCENTS
- SALTER-HARRIS I OR II
- NEED A TRUE LATERAL RADIOGRAPH
- MAY MIMIC MALLET FINGERS – BUT DISPLACEMENT OCCURS THROUGH FRACTURE (EXTENSOR TENDON INSERTION IS UNINJURED)
Clinical appearance (left image) and radiographic appearance (right image) of a Seymour fracture.
(Photograph and radiograph courtesy of Children’s Orthopaedic Surgery Foundation.)
SEYMOUR FRACTURES

• TREATMENT
  • IRRIGATION AND DEBRIDEMENT
  • CAREFUL EXPLORATION TO REMOVE THE PROXIMAL NAIL PLATE FROM THE SITE OF INCARCERATION
  • ONCE NAIL PLATE AND NAIL BED ARE REMOVED – THE FRACTURE IS EASILY REDUCED
  • NAIL PLATE CAN BE USED TO HELP WITH STABILIZATION
  • MAY ALSO NEED A K-WIRE THROUGH THE DIP
  • 4 WEEKS IMMOBILIZATION
SEYMOUR FRACTURES

• LATE PRESENTATION
  • INFECTION
  • GROWTH ARREST
  • PERSISTENT MALLET DEFORMITY

• TODDLER VARIANT
  • COMPLETE DORSAL ROTATION OF THE EPIPHYSIS (SH I)
Problematic Pediatric Hand and Wrist Fractures.
Goodell, Parker; Bauer, Andrea
DOI: 10.2106/JBJS.RVW.O.00028

Intraoperative photograph demonstrating a fracture open through the germinal matrix (left image), and photograph of a nail deformity resulting from a chronic Seymour fracture (right image). (Photographs courtesy of Children’s Orthopaedic Surgery Foundation.)
BONY MALLET FINGER FRACTURES

• FLEXION FORCE DIRECTED TO AN ACTIVELY EXTENDED FINGER
• EXTENSOR TENDON AVULSES A FRAGMENT OF THE EPIPHYSIS
• INTRA-ARTICULAR
• TREATMENT SIMILAR TO ADULTS
  • LESS THAN 1/3 OF JOINT SURFACE – EXTENSION SPLINTING
  • PERSISTENT Volar SUBLUXATION, GREATER THAN 50% OF JOINT SURFACE – SURGERY
  • IF COMPLIANCE IS AN ISSUE – CONSIDER EXTENSION BLOCK PINNING
• TREATMENT CAN BE SUCCESSFUL EVEN WITH LATE PRESENTATION
Lateral radiographs of an acute mallet fracture without joint subluxation (arrow) before (left image) and after (right image) splint treatment. (Radiographs courtesy of Children's Orthopaedic Surgery Foundation.)
The surgical technique for extension block pinning of large mallet fractures. Fig. 4A After the digit is appropriately anesthetized, and with the aid of fluoroscopy, the distal interphalangeal joint is maximally flexed. Fig. 4B A 1.4-mm (0.045-inch) Kirschner wire is introduced under fluoroscopic guidance through the extensor tendon at a 45[degrees] angle into the distal portion of the middle phalanx. The distal phalanx is then extended and is translated, compressing the fragment and acting as an extension block. Occasionally, manipulation of the distal phalanx against the extension-block Kirschner wire is required to obtain an anatomic reduction. Fig. 4C A second Kirschner wire is inserted longitudinally from distal to proximal across the distal interphalangeal joint. Note that full extension of the joint is not necessary. (Reproduced, with permission of Elsevier, from: Hofmeister EP, Mazurek MT, Shin AY, Bishop AT. Extension block pinning for large mallet fractures. J Hand Surg Am. 2003 May;28:453-9. Copyright [2003]).
Fixation of an adolescent bony mallet fracture using Ishiguro extension block technique.

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**Pediatric Hand Fractures**


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CONDYLAR SPLIT FRACTURES

- INTRA-ARTICULAR
- OFTEN LATE PRESENTATION
- “DOUBLE DENSITY” SIGN ON TRUE LATERAL RADIOGRAPH
- NEEDS PERFECT REDUCTION
- FRAGMENTS ARE OFTEN TINY – ESPECIALLY IN THE PEDIATRIC POPULATION
CONDYLAR SPLIT FRACTURES

• TREATMENT
  • IF EARLY PRESENTATION – CLOSED REDUCTION AND PERCUTANEOUS PINNING
  • IF OPEN REDUCTION – NEED TO PROTECT SOFT TISSUE ENVELOPE BECAUSE OF RISK OF AVN
  • EXTREMELY DIFFICULT TO CORRECT INTRA-ARTICULAR MALUNION
Two-year-old girl with an unwitnessed injury to her left index finger. She presented 10 months later with an intracondylar proximal phalanx malunion. Due to persistent deformity and inability to form a closed fist, she underwent a corrective osteotomy ...

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PHALANGEAL NECK FRACTURES

• FRACTURE LOCATED DISTAL TO THE COLLATERAL LIGAMENT RECESS
• DISTAL CONDYLAR FRACTURES
• DISPLACE INTO EXTENSION WITH DORSAL TRANSLATION – VOLAR BONE SPIKE PREVENTS FLEXION
• TRUE LATERAL RADIOGRAPH
• ONLY OCCUR IN CHILDREN
PHALANGEAL NECK FRACTURES

• TREATMENT
  • NEED TO ASSESS RADIOGRAPH
  • CAN OFTEN BE REDUCED CLOSED (NO JOINT EXTENSION)
  • IF > 1-2 WEEKS – DUE TO RAPID HEALING IN CHILDREN, OFTEN CLOSED REDUCTION IS UNSUCCESSFUL
  • RISK OF NON-UNION, AND AVN
  • PINS ARE USUALLY LEFT FOR AT LEAST 4 WEEKS (POOR BLOOD SUPPLY AND LACK OF SOFT TISSUE ATTACHMENTS)
Three-year-old girl presented 2 weeks after right small finger injury. Radiographs show a small finger DCP fracture, with no bony contact (type III). Despite efforts to reduce and stabilize the fracture, the fracture went on to a nonunion with minimal ...

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PROXIMAL PHALANX FRACTURE

• NEED TO ASSESS ORIENTATION OF THE FRACTURE AND DEGREE OF INITIAL DISPLACEMENT
• PHYSICAL EXAMINATION IS VERY IMPORTANT
  • ASSESS ROTATION
• LENGTH STABLE FRACTURES
  • BUDDY TAPING 3-4 WEEKS
• OBlique/Spiral FRACTURES
  • Ulnar/Radial Gutter CAST
  • MONITOR CLOSELY FOR DISPLACEMENT
PROXIMAL PHALANX FRACTURE

• REMEMBER
  • CAST WILL NOT HOLD FRACTURE “OUT TO LENGTH” – CAN ONLY CONTROL RADIAL AND ULNAR DEVIATION
  • LENGTH UNSTABLE FRACTURES OFTEN NEED PINNING OR ORIF

• FRACTURES AT THE BASE OF THE PROXIMAL PHALANX
  • MOST COMMON IN SMALL FINGER (EXTRA OCTAVE FRACTURE)
  • SALTER HARRIS I OR II
  • USUALLY CLOSED REDUCTION
  • FLEXOR TENDON ENTRAPMENT, DISRUPTION OF COLLATERAL LIGAMENTS OR FRACTURE COMMINUTION CAN BLOCK REDUCTION
ADDITIONAL THOUGHTS

- MOST PHALANGEAL AND METACARPAL FRACTURES ARE MINIMALLY DISPLACED AND STABLE
  - WELL MANAGED IN A SPLINT/CAST

- BEWARE OF THE “HOUDINI PHENOMENON” ESPECIALLY IN YOUNG CHILDREN!
  - LONG ARM CAST
  - 2-3 LAYERS OF PADDING ONLY TO PREVENT MOTION AND SLIPPING OF THE CAST
  - SUPRACONDYLAR MOLDING

- K-WIRES CAN HELP MAINTAIN A REDUCTION

- MOST DO NOT NEED TO BE IMMobilIZED MORE THAN 4 WEEKS
ADDITIONAL THOUGHTS

• FOR ACUTE DISPLACED FRACTURES
  • CLOSED REDUCTION AND PERCUTANEOUS PINNING IS THE STANDARD
  • IF NEEDED A LIMITED APPROACH CAN OFTEN BE USED TO REMOVE INTERPOSED TISSUE
  • K-WIRES CAN BE USED AS “JOY STICKS” TO AID IN FRACTURE REDUCTION
  • WIRES ARE USUALLY LEFT OUTSIDE OF THE SKIN AND SHOULD BE PROTECTED WITH EITHER A CAST OR A BRACE

• PEDIATRIC PEARL – USE ABSORBABLE SUTURES!!!!