Chronic growth plate fractures in adolescent athletes

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Anatomy

- The growth plate (physis) is located between the epiphysis and metaphysis
- This is where the endochondral ossification takes place
Anatomy

- Proliferating Zone: Bone growth through proliferation of cells. Fracture here = normal growth is inhibited.
- Hypertrophic zone: between the cartilage cells extracellular matrix is produced which then calcifies leading to a pillarlike structure. Fractures occur most often between the uncalcified and calcified areas.
- Ossification zone: Bone and cartilage cells are being remodelled, removed and replaced by secondary spongiosa.
Basics

• Epiphyseal cartilage is more prone to fracture than adult cartilage and the bone next to it\textsuperscript{1,2}. Furthermore it is weaker than the other tissue around it\textsuperscript{3}.

=> Thus, an injury leading to a ligament tear or a luxation of a joint in adults, will lead to an epiphyseal fracture in children
Basics

• In animal studies the growth plate was weakest during puberty$^3$.
• Results in humans comparable$^4$-$^6$.
• Reasons:
  – Heightened growth leads to thicker and more fragiles growth plates$^4$
  – Mineralisation probably lacks behind linear growth$^7$
  – Whether or not a more pronounced muscle tension as a consequence of growth is important controversial$^8$
• Most fractures occur during puberty, during the growth peak$^9$,$^{10}$. 
Classification

I  Proliferation
Zone not involved

II  Fracture Through Metaphysis

III  Fracture Through Epiphysis

IV  Fracture Metaphysis, Epiphysis, And Physis

V  Compression Of the physis With Premature Closure and End to further growth
Pathophysiology

• Cause: Repetitiv trauma

• Consequence:
  – Decreased metaphyseal blood flow
  – Mineralisation of hypertrophic chondrocytes hindered\(^1\)
  – However growth is unperturbed\(^1\)

• Normally this is only temporary as the blood flow is only decreased over short periods of time

• When decreased blood flow is maintained:
  – Necrosis of the bone
  – Bone growth disturbed
  – Imbalanced: Assymetric growth
  – Balanced: Retardation or even End of growth
Little League Shoulder
Anatomy Schulter

Epiphysis

Physis (growth plate)

Metaphysis

Diaphysis

Capital femoral epiphysis

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Pathomechanism

• Shoulder is like hold of a whip with the arm and underarm being the whip

• 2 muscle sets:
  • External: Pectoralis major, Delta, Triceps inserting on the humerus distal to the proximal physis
  • Internal: Supraspinatus, Infraspinatus and Supscapularis inserting on the Tuberositas proximal of the proximal physis

• At the end of the throw the force pulls the arm away from the glenoid, leading to traction on the physis
Pathomechanism
Presentation

- Pain at the end of the throw
- Pain is not localized
- Examination is normal except for pain when pressure is applied over the physis or the movement of throwing is simulated
X-Ray

Salter-Harris I
Therapy and Outcome

• Rest$^{16}$ for at least 3 months

• Until the closure of growth plate no more pitching. Baseball only on first base $^{16}$

• One operation for removal of free bone material with full recovery $^{17}$

• 38 cases treated conservatively, all with full recovery.
Guidelines

• Pitching only for two innings per game\textsuperscript{16}
• Shoulder problems lead to end of pitching and taking up another position\textsuperscript{16}
• No Home-Training \textsuperscript{16}
• No Curve Balls \textsuperscript{16}
• Medical control on local and national level\textsuperscript{16}
Little League Shoulder bei anderen Athleten

- Swimming
Radius in Gymnastics
Lower extremity

• Mainly running
  – Long distance
  – Running as a consequence of the sport (Basketball, Soccer, Football)

• Sports involving kicking
  – Rugby
  – Soccer
Climbing
Forces acting on the growth plate

Direction of force from the flexor tendons
Presentation

- No real Trauma
- Pain increased slowly over time
- Flexion and extension of finger limited
- Pain upon pressure over the dorsal aspect of the finger middle joint
- Overall 60 fractures, 24 described in detail, of which there were 23 boys, 1 girl
- X-ray: Mainly Salter Harris III.
- When X-Ray was normal often Salter Harris I – II in MRI
Study on epiphyseal fractures of the finger

• Over the last ten years: 19 adolescents with finger pain of which 18 had chronic epiphyseal fractures in 22 fingers.
• 15 boys and 4 girls
• All were 14.4 months in average after onset of puberty (thelarche in girls, pubarche in boys)
• All were climbing at a high and/ or competition level (UIAA 9 and up)
Results

- The middle finger was concerned in 21 of 22 fingers (95%)
- The main grip form at the moment of injury was the crimp grip (64%), which was also the preferred handhold (71%)
- 86% of the patients were participating in bouldering competitions
- 18 fractures were Salter Harris III, two were grade I and two grade V
- 71% stated they had warmed up properly
- Campus board was done by almost no subjects (0.2 h/week), most were climbing (3.6 h/week) or bouldering (3.2 h/week) for training
- 13 adolescents remembered an acute event leading to the trauma
Therapie and Outcome

- Splint for 3 – 4 weeks and rest from climbing for a minimum of 6 weeks
- With Compliance good Outcome
- 2 athletes did not follow our advice and now have ulnar deviation of the finger in one case and a rotated finger in the other case. Both fingers are not fully functional
Outcome
Gender distribution

Testosteron
Literatur

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Thank you for your attention