Key note medicine
Finger injuries in rock climbing

V. Schöffl
Epidemiology of sport climbing injuries

Definitions: 5 major types of climbing

- mountaineering
- traditional (alpine) rock climbing
- sport climbing (incl. bouldering)
- indoor climbing (including competition climbing)
- vertical ice climbing (including frozen waterfalls)

All have different risks in accordance to objective danger, environmental hazards, safety margins etc.
Climbers are an inhomogenous group: No age limitation

Fred Beckey 88y, 2013 90th birthday

Luc and Keo 1y9m
Gender

- Alpine, sport and indoor climbing: inhomogeneous gender distribution (Schöffl, Neuhof, Jones, Josephsen, Backe, Bowie, Schussmann and more)
- Ice climbing: female climbers were injured more often (76.9%) than males (58.7%) (Schwarz, Schöffl)
- Mountaineering: Inhomogeneous distribution (McIntosh, Schussmann, Stephens). In fatal accidents significantly more men are involved than women (Küpper).
Anatomical location

- Sport and Indoor climbing: Mostly upper extremity, mostly overstrain injury
- Alpine Climbing: Mostly lower extremity due to fall
- Ice Climbing: Head and the upper extremity
- Mountaineering: 36% head or vertebral column, 14.3% trunk, 25.5% legs, and 14.1% arms (Küpper et al.)

(see review: Schöffl et al. 2012)
Injury Type

- Alpine, sport and indoor climbing: fractures, strains and sprains are predominant, hand and finger injuries are the most common (see review: Schöffl et al. 2012).

- Ice Climbing: Mostly open wounds and haematoma (Schwarz, Schöffl)

- Mountaineering: associated with higher graded trauma, multiple fractures, severe wounds and polytraumatic patients (Küpper)

<table>
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<tr>
<th>Body area</th>
<th>2009 -</th>
<th>2012 -</th>
<th>1998 -</th>
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One Move too Many

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<tr>
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(Schöffl, Hochholzer, Winkelmann, Strecker, Dt.Z.f.Sportmed.2/2003 and Schöffl et al. 2014 in progress)
**Differential diagnoses of finger injuries 2009 – 2012 (n=474) and 1998 – 2001 (247)**

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<td>16.9</td>
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<td>Capsulitis</td>
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<td>Strain flexor tendon</td>
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<td>Collateral ligament injury</td>
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<td>Fingeramputation</td>
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<td>Flexor contraction</td>
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<td>0.2</td>
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</table>

(Schöfl, Hochholzer, Winkelmann, Strecker, Dt.Z.f.Sportmed.2/2003 and Schöfl et al. 2014 in progress)
Climbing and Hanging Fingerposition

One move too many
Finger Injuries: Clinical Examination

- Collateral ligaments
- Palmar plate
- FDP
- FDS
- Pulleys
Finger Injuries: Clinical Examination

- Collateral ligaments
- Palmar plate
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Finger Injuries: Clinical Examination

- Collateral ligaments
- Palmar plate
- FDP
- FDS
- Pulleys
Pulley Injury

- Most frequent climbing injury.

- Firstly reported in rock climbing. (Bollen 1990 J Hand Surg [Br], Tropet 1990 J Hand Surg [Am])


- Cause: mostly dynamic move in crimping position.

- Nowadays also seen in non-climbers. (Schöffl & Jüngert 2006, Jüngert, Neuhuber, Schöffl 2006)
Pulley Injury
Pulley Injury

Pulley Injuries n=280 (1998-2006)

Schöffl, Schöffl: J Hand Surg [Am]
Pulley Injury: Diagnostics

- History
- Clinics
- X-Ray
- Ultrasound
- MRI

Suspected pulley rupture
- X-Ray
  - Fracture
    - Yes
    - Ultrasound
      - Dehiscence tendon to bone
        - < 2 mm
          - Strain
            - Symp. therapy
        - > 2 mm
          - Single rupture
            - Cons. therapy
          - Multiple ruptures
            - Surgical repair
        - Questionable
          - MRT

Pulley Injury: Clinical Picture - Bowstring
Pulley Injury: Ultrasound
Pulley Injury: Ultrasound
One move too many
# Pulley Injury: Grading

<table>
<thead>
<tr>
<th>Grade</th>
<th>Injury</th>
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</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>Pulley strain (dehiscence of the flexor tendons to the bone &lt; 2mm)</td>
</tr>
<tr>
<td>Grade II</td>
<td>Complete rupture of A4 or partly rupture of A2</td>
</tr>
<tr>
<td>Grade III</td>
<td>Complete rupture A2 or A3</td>
</tr>
<tr>
<td>Grade IV</td>
<td>Multiple ruptures, as A2/A3, A2/A3/A/4 or single rupture (A2 or A3) combined with Mm. lumbricalis or collateral ligament trauma</td>
</tr>
</tbody>
</table>

# Pulley Injury: Therapy

<table>
<thead>
<tr>
<th>Injury</th>
<th>Grade I</th>
<th>Grade II</th>
<th>Grade III</th>
<th>Grade IV</th>
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</thead>
<tbody>
<tr>
<td>Pulley strain</td>
<td>Complete rupture of A4 or partly rupture of A2 or A3</td>
<td>Complete Rupture A2 or A3</td>
<td>Multiple ruptures, as A2/A3, A2/A3/A/4 or single rupture (A2 or A3) with Lumbricalis or ligamental trauma</td>
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<table>
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<tr>
<th>Therapy</th>
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<th>Conservative</th>
<th>Conservative</th>
<th>Surgical Repair</th>
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<tr>
<td>Immobilisation</td>
<td>None</td>
<td>10 days</td>
<td>10-14 days</td>
<td>Postoperative 14 days</td>
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<tr>
<td>Functional therapy</td>
<td>2-4 weeks</td>
<td>2-4 weeks</td>
<td>4 weeks</td>
<td>4 weeks</td>
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<tr>
<td>Pulley protection</td>
<td>Tape</td>
<td>Tape</td>
<td>Thermoplastic ring Tape</td>
<td>Thermoplastic ring</td>
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<tr>
<td>Easy sport specific activities</td>
<td>After 4 weeks</td>
<td>After 4 weeks</td>
<td>After 6-8 weeks</td>
<td>4 month</td>
</tr>
<tr>
<td>Full sport specific activities</td>
<td>6 weeks</td>
<td>6-8 weeks</td>
<td>3 month</td>
<td>6 month</td>
</tr>
<tr>
<td>Taping through climbing</td>
<td>3 month</td>
<td>3 month</td>
<td>6 month</td>
<td>&gt;12 month</td>
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</table>

Schöffl et al. Hand Mikr Plast 2004
Pulley Injury: Surgical Graft
Pulley Injury: Surgical Graft – Retinakulum extensorum
Pulley Injury: Surgical Graft – One and a half loop and Weilby’s Repair – Bamberg Repair

Schöni et al. J Hand Surg Am 2012
Pulley Injury: Surgical Graft – One and a half loop and Weilby’s Repair (S.A.14 m post op)
Pulley Injury: Pulley Support - Soft cast

One move too many
Pulley Injury: Taping - „Isa“-Tape

Pulley Ruptures Outcome

- 122 Pulley Ruptures:

  - 81 Grade 1-3 re-evaluated:
    - 80 no symptoms, 1 operative tenosynovectomy and pulley repair.
    - All are climbing again.

  - 7 Grad 4: (surgery): Buck-Gramcko Score very good 4, good 2, fair 1

  Schöffl et al. Hand Mikro Plast Chir 2004

- No strength deficit in the former injured finger (cons.Tx).
  (21 patients with 27 pulley ruptures).

# Pulley Ruptures Outcome: „Bamberg“-repair

## Pulley Injuries 1998-2010 (n=462)

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<tbody>
<tr>
<td><strong>Pulley strain</strong></td>
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<td>63</td>
<td>55</td>
<td>101</td>
<td>17</td>
<td>4</td>
<td>50</td>
<td>62</td>
<td>2</td>
<td>3</td>
<td>68</td>
<td>9</td>
<td>37</td>
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<td>176</td>
<td>168</td>
<td>293</td>
<td>51</td>
<td>8</td>
<td>122</td>
<td>204</td>
<td>10</td>
<td>7</td>
<td>140</td>
<td>13</td>
<td>121</td>
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<td>4</td>
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### Handness

<table>
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<tr>
<th>Handness</th>
<th>Pulley rupture</th>
<th>Presurgical extension deficit PIP or DIP joint</th>
<th>Re-evaluation after</th>
<th>Postsurgical extension deficit PIP or DIP joint</th>
<th>Initial climbing level (UIAA metric-scale [30])</th>
<th>Outcome Buck-Gramcko Score [28]</th>
<th>Climbing level after the healed injury (UIAA metric-scale [30])</th>
<th>Functional outcome Schöffl Score [31]</th>
<th>Sport-specific outcome Schöffl Score [31]</th>
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<tbody>
<tr>
<td>right</td>
<td>A2/3/4</td>
<td>10° PIP</td>
<td>18 months</td>
<td>10° PIP</td>
<td>6.5</td>
<td>15</td>
<td>6.5</td>
<td>good</td>
<td>excellent</td>
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<tr>
<td>right</td>
<td>A2/3</td>
<td>10° PIP</td>
<td>19 months</td>
<td>10° PIP</td>
<td>9.7</td>
<td>15</td>
<td>9.7</td>
<td>good</td>
<td>excellent</td>
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<tr>
<td>right</td>
<td>A2/3</td>
<td>5° PIP</td>
<td>18 months</td>
<td>5° PIP</td>
<td>7.3</td>
<td>15</td>
<td>8.7</td>
<td>good</td>
<td>excellent</td>
</tr>
<tr>
<td>right</td>
<td>A2/3/4</td>
<td>20° PIP</td>
<td>12 months</td>
<td>30° PIP</td>
<td>6.7</td>
<td>15</td>
<td>5.0</td>
<td>fair</td>
<td>satisfying</td>
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<tr>
<td>right</td>
<td>A2/3/4</td>
<td>25° PIP</td>
<td>52 months</td>
<td>25° PIP</td>
<td>7</td>
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<tr>
<td>right</td>
<td>A2/A3</td>
<td>10° PIP</td>
<td>6 months</td>
<td>10° PIP</td>
<td>8.7</td>
<td>15</td>
<td>8.7</td>
<td>good</td>
<td>excellent</td>
</tr>
</tbody>
</table>

One move too many

Schöffl et al. J Hand Surg Am 2012
Neglected Injuries: diagnosed as A2, in reality A2,3,4
Pulley Ruptures: Chronic tenosynovitis - FLIP (Flap irritation phenomenon)

Schöffl et al. 2010
Pulley Ruptures: Chronic tenosynovitis - FLIP (Flap irritation phenomenon)
Joint Capsular Injury

One move too many
Joint Capsular Injury
Joint Capsular Injury

- Overstrain, partial or complete rupture, # palmar plate
- Initial Tx: RICE, finger compression
- Immobilisation
- Early functional tx.
- NSAID, physiotherapy
- Finger exercises
- Tape
Joint Capsular Injury
Joint Capsular Injury

- Overstrain, partial or complete rupture, # palmar plate
- Initial Tx: RICE, finger compression
- immobilisation
- Early functional tx.
- NSAID, physiotherapy
- Finger exercises
- Tape

- Rest
- Ice
- Compression
- Elevation
Joint Capsular Injury

- Overstraining, partial or complete rupture, # palmar plate
- Initial Tx: RICE, finger compression
- Immobilisation
- Early functional tx.
- NSAID, physiotherapy
- Finger exercises
- Tape
Joint Capsular Injury: Taping
Joint Capsular Injury: Taping
Chronic Capsular Damage – Neglected Injuries

- Reduced range of motion, morning stiffness
- X ray
- 32/75 climbers with swellings of the finger joints (Hochholzer et. al. 1993)
- Reversible if detected early (GJNT)
- Tx: stress reduction, movement, prophylaxis externa (sulphur), RSV
Injury of Collateral Ligaments
Injury of Collateral Ligaments

- Osseous injury
- Instability
- Cons.Tx
- Rarely surgery
Injury of Collateral Ligaments

- Osseous injury
- Instability
- Cons.Tx
- Rarely surgery
Tendonitis - Tenosynovitis - Tendovaginitis
Tendonitis: Cause, Symptoms

- Crimping Position
- „Sloper“
- Pressure tenderness base of phalanx palmar
- Swelling, rush, hyperthermia
Tendonitis: Diagnosis

- Clinical
- Ultrasound
- MRI
Tendonitis: Therapy

- Stress reduction
- Splint immobilisation
- NSAD, enzymes
- lokal injections (steroids, hyaluronic acid)
- Ice therapy, brush massages
- Sulphur baths
- Tape for climbing
M. Dupytren

- Disease of the palmar aponeurosis
- 40-60 J
- Increased numbers in climbers, already in young age
- Chronic microtrauma
- Cons. Tx, rarely surgery, radiation tx
Ganglions

- Tendon sheath or pulley
- Tx. Cons, local steroids, rarely surgery
Ganglion

- Ausstülpung der Gelenkkapsel oder Sehnenscheide
- Zunehmende Häufung bei Kletterern
- Gangliongröße ist belastungsabhängig
- Therapie: symptomatisch, ggf. operativ
Fractures
Stress/Fatigue Fractures of the Epiphysis

- 1997 firstly reported. Hochholzer, Schöffl et al. Sport Ortho Trauma
- Increasing number: we treated > 100 junior high level climbers (Age MW = 13.4) (FRG, Austria, UK, Netherlands, USA, Brasilia, Tschechia, Slovakia, ...)

Hochholzer, Schöffl et al. Sport Ortho Trauma 2002, Wild Env Med 2005
Stress/Fatigue Fractures of the Epiphysis

- Non traumatic epiphyseal fractures
  Aitken II, S-H III.
Stress/Fatigue Fractures of the Epiphysis

- Non traumatic epiphyseal fractures
  Aitken II, S-H III.
Stress/Fatigue Fractures of the Epiphysis

One move too many

2y later

Hochholzer, Schöffl Wild Env Med 2005
Stress/Fatigue Fractures of the Epiphysis: Course
Stress/Fatigue Fractures of the Epiphysis: Early diagnosis !!!
Stress/Fatigue Fractures of the Epiphysis: Therapy

- Rest (8w, than controll MRI)
- Immobilisation if necessary
- Surgery

**PREVENTION!**

Schöffl et al. (MedCom UIAA) 2004
Stress/Fatigue Fractures of the Epiphysis: Rule of thumb

- **Rule of thumb:**

- For **coaches**: if a young climber 12-16 y has pain in the fingers after training or in the morning without trauma: rest for 1 week, if does not resolve see competent doctor.

- For **doctors**: unclear finger pain/swelling of more than one week without trauma in young climbers 12-16y must get MRI by competent radiologist.
5 year follow up after epiphyseal fracture
Capsulitis

- Cons Tx
- Externals
- NSAIDs
- Sulphur
- Injections
- RSO
- Ammoniumbituminosulfonat (20%) (ICHTHOLAN)
Capsulitis

- Cons Tx
- Externals
- NSAIDs
- Sulphur
- Injections
- RSO (Erbium 169)
- Ammoniumbituminosulfonat (20%) (ICHTHOLAN)
Lumbrical Shift Phenomen
Lumbrical Tear
Tendon ruptures
Tendon ruptures

One move too many
Tendon ruptures

One move too many
Tendon ruptures
2 y later contralateral side

One move too many
Tendon ruptures
Tendon ruptures

One move too many
Extensor hood syndrome
Extensor hood syndrome
Extensor hood syndrome
Extensor hood syndrome (K.L.)

One move too many
Extensor hood syndrome (K.L.)

One move too many
Extensor hood syndrome (K.L.)
Bone Spurs (G.J.)

One move too many
Infections!

- Don’t forget the normal pathologies !!!
Finger and Hand Special: Rope Tangling Injury

One move too many
Finger and Hand Special: Rope Tangling Injury
Finger and Hand Special: Rope Tangling Injury

One move too many
Finger and Hand Special: Rope Tangling Injury
Air Position!

One move too many
Fingerring

One move too many
Common Finger Injuries

- Capsular Damage
- Collateral Ligament Injury
- Pulley Injury
- Tendovaginitis
- Fracture
- Epiphyseal Fractures
- Trigger Finger
- Dupuytren Contracture
- Osteoarthritis
- Ganglion
- Infection
- Lumbrical Shift Syndrome
- Amputation

Schöffl et al. D Z Sportmed 2007

One move too many
One move too many