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# Finger injuries of young elite rock climbers

## Summary

Objectives. Based on reports of major overuse injuries in the fingers of adult elite rock climbers, we performed a cross-sectional study of young Swiss elite rock climbers to assess the finger injury patterns and search for possible risk factors.
Methods. Twenty-nine 10- to 17-year-old nationally ranked rock climbers took part in the study. Climbing and injury history was assessed by interview, followed by a clinical examination of the hands and antero-posterior and lateral radiographs of both hands. Injury pattern and possible predictors of injury were determined. The climbers were divided into two groups: group 1 included those with current pain in the finger (n = 21) and group 2 was free of pain (n = 8).
Results. Twenty-one of 29 climbers reported current or recurring pain in the fingers. Clinical findings among both groups consisted of swelling in the affected PIP/DIP joints, radio-ulnar laxity and/or an extension deficit in the affected PIP or DIP joints, and mild bowstringing of the pulley system. Radiologically there was one old flake fracture and four abnormalities of the epiphysis as a possible sign of a previous epiphyseal injury of the affected joints. The only clinical finding among the injured climbers, which discriminated group 1 from group 2 was swelling of the proximal interphalangeal joints (chi-square, $p < 0.05$). Age, weight, general laxity, start of regular climbing training (age), climbing difficulty, increase in climbing difficulty per year, training volume during the last season, climbing technique and grip strength did not predict injury. No severe injuries were found in this study.
Conclusion. Young elite rock climbers are prone to finger pain as possible sign of injury or overuse. Despite extensive load application to the fingers of our young elite rock climbers, they do not show major injuries, even though pain is a common finding. Nevertheless, those with pain, swelling or a deficit of range of motion in the PIP or DIP joints of the finger should be evaluated to exclude intraarticular lesions such as epiphysiolysis as previously reported.

Key words:
Rock climbing, injury, fingers, youth

Schweizerische Zeitschrift für «Sportmedizin und Sporttraumatologie» 50 (1), 7–10, 2002

## Introduction

Overuse injuries are common among elite rock climbers [1–17]. While technical difficulties have increased, the age of climbers has decreased. Many young climbers have little training in appropriate climbing techniques to prevent injury. Therefore, it is not surprising that the frequency and severity of injuries has increased. Better protection and improved technical gear have helped to reduce acute injuries from falls, but overuse injuries of the soft tissue, mainly of the hands, continue to increase.

Among all climbing injuries in adult elite rock climbers the percentage of hand injuries has been described to be as high as 50 to 70% with a majority of the injuries located in the fingers [1, 2, 3, 4, 6, 18]. The finger injuries mainly affect the proximal (PIP) and distal (DIP) interphalangeal joints of the middle and ring fingers with an equal distribution between left and right [1, 2, 4, 6]. In one study by Bollen et al. [1] the first metacarpo-phalangeal joint (MP) was also a site of pain. Common injuries include A2 pulley tears or strains, fixed flexion deformities of the PIP joints or tenosynovitis of the finger flexors [1, 2, 4, 6, 9]. A report from Hochholzer et al. [19] who describe five junior sport climbers with an epiphysiolysis of the PIP joint solely due to overuse, seems especially alarming.

Previous reports have been purely descriptive without any consideration of possible risk factors. Additionally, most of the data were from adult climbers. It is not known whether young climbers, who are still growing and developing, are more prone to injuries. The study was performed 1. to evaluate the injury pattern among adolescent nationally ranked sport climbers specifically looking for finger injuries and potential epiphysiolysis and 2. to evaluate possible risk factors which might lead to injuries.

## Methods

Of all 65 nationally ranked 10- to 17-year-old Swiss sport climbers (youth category) who were asked to participate in the study, twenty-nine (45%) agreed. Adolescents and parents were informed about the study design and gave their written consent to participate in the study. The study was approved by the ethical committee of the Institute of Sports Science, Magglingen, Switzerland.

Body weight and height were measured barefoot and in light clothes. Skinfold thickness over the triceps muscle and subscapular region were measured by a Harpenden caliper and the percentage of body fat was calculated according to the method of Slaughter et al. [20]. A physical examination of the adolescent climbers with special attention to the musculo-skeletal system was performed. The 9-point Beighton scoring system [21] was used to determine laxity of the joints. One point was given on each side each of the following: passive dorsiflexion of the fifth metacarpo-phalangeal joint to 90° or more, the apposition of the thumb to the flexor aspect of the forearm, hyperextension of the elbow and knee beyond 10°, and forward trunk flexion placing hands flat on floor with knees extended. Antero-posterior and lateral radiographs of both hands were obtained. All radiographs were examined by a radiologist who was not informed of the clinical findings. Those

climbers with severe acute pain and swelling in one or more DIP or PIP joints had an MRI. A hand surgeon examined both hands of the climbers without having knowledge of the x-ray findings. Each climber performed a grip strength measurement with a Jamar hydraulic hand grip dynamometer (Asimow Engineering Co., Santa Monica, CA, USA). The test was taken in the sitting position with the elbow flexed at 90° and the forearm resting on the table. Three consecutive tests with the left and right hand alternating were measured and the test with the highest value was taken for further evaluation.

The climbers were divided into two groups: group 1 comprised those with actual pain in the fingers, while group 2 was asymptomatic. Age, height, body weight, percentage of body fat, laxity score (0 to 9), start of regular climbing training (age), increase in climbing difficulties (highest grade and increase in grade per year), specific climbing and general physical training volume during the last season (hours per week), climbing techniques such as position of the fingers while climbing on small grips, one finger climbing, grip strength and use of an initial warm up were evaluated as possible risk factors for injury.

Statistics: A Pearson's chi square test was performed between the groups. A p-value of less than 0.05 was considered significant. The data were analyzed using a Social purgeon for social sciences package (SPSS, Chicago IL, 1989).

## Results

The characteristics of the climbers are listed in Table 1. There were 26 males and 3 females. All were climbing at a UIAA grade of 7–9 with an average climbing career of little more than 2 years. Climbing training consisted of 5.88 ± 3.27 (range 1–14) hours per week. Total training (climbing and other sports included) was 8.83 ± 4.12 (range 2–21) hours per week. Grip strength of the left and right hand was 38.45 ± 9.52 (range 21–54) and 38.76 ± 9.91 (range 21–52) kg, respectively, and the laxity score was 2.15 ± 2.74 (range 0–9). Only one athlete performed finger strengthening with additional weights and only two climbers trained by hanging on single fingers. Ten climbers did training on small ledges which might be harmful to joints, but the training volume was only 15 min to two hours per week.

Clinically, all hands appeared strong with signs of an adaptative hypertrophy of all soft tissues. The skin of the palmar side of the hand as well as of the fingers was thick and showed callosities with thickened subcutaneous tissue. There were no signs of a compression neuropathy or tendinitis or tendovaginitis of the flexor- and extensor systems. Three athletes demonstrated laxity of the pulley system with minimal bowstringing of the flexor tendons of 2–3 mm. Only one of them experienced pain in this area. The interphalangeal joint of the thumb was generally hypertrophied with increased radio-ulnar translation. The MP joints of all fingers were strongly built with a voluminous joint capsule. Nine athletes showed asymptomatic discrete ulnar or radial instability and one athlete asymptomatic palmar subluxation under stress. The intrinsic musculature appeared normal in the whole group. Most striking were changes in the PIP joints. They were disproportionally strong with an extremely strong collateral joint capsule. Ten athletes showed mild to moderate, usually symmetrical instability (radial or ulnar deviation of the PIP joints up to 10° from the neutral position) and three of them also showed dynamic swan-neck deformities with painless crepitation and snapping. Passive hyperextension of the PIP joints of 10–20° was found in 10 athletes; the PIP joints of the 2nd up to the 5th digit were equally affected. The PIP joints could be actively brought into extreme flexion up to contact of the palmar joint margin against the neck of the proximal phalanx. Only one climber experienced impingement in this position. 9 athletes showed a passive hyperextension of 15–70° in the DIP joints.

Radiographically, four athletes were found to have abnormalities in the epiphysis of PIP joints of the fingers indicating a possible injury at or near the epiphysis. They all preferred to climb with the fingers upright («crimp grip»: hyperflexion of the PIP and hyperextension of the DIP joints). The first showed a flake fracture at the base of the distal phalanx of the ring finger with a dorsally enlarged epiphysis of the middle and ring finger, where he recalled a sprain two years before. Another demonstrated a metaphyseal sclerotic zone of P2 and cone-shaped imprinting of several epiphyses where he experienced intermittent pain. These radiological findings could be considered as sign of incomplete epiphysiolysis after repetitive microtrauma. Two climbers were found to have an enlarged epiphysis of the proximal phalanx of the thumb indicating a possible previous capsular tear and one climber showed a premature closure of the epiphysis of the proximal phalanx of the thumb. Three climbers with acute pain in one or several DIP or PIP joints underwent MRI examination. MRI revealed small amounts of liquid between the deep flexor tendon and the phalanx. No injury of the epiphysis or pulleys could be detected.

Table 2 describes the prevalence of actual symptoms and pathological findings of the fingers at clinical examination or radiographically divided by the two groups. In group 1, there were 16 climbers with finger pain who demonstrated clinical and/or radiographic abnormalities and five climbers with finger pain but without clinical or radiographic pathology.

Fifteen climbers reported climbing injuries. Twelve of these had finger injuries. The fingers affected were the thumb in two climbers and the 2nd through 4th digits in the others with an evenly distribution among the fingers and between left and right.

| | Mean (SD) | Range |
|---|---|---|
| Age (yr) | 14.7 (1.6) | 10.2–16.8 |
| Body weight (kg) | 52.2 (12.1) | 31–77 |
| Height (cm) | 165.8 (12.4) | 136–185 |
| Body fat (%)[1] | 11.1 (2.9) | 7.3–18.2 |
| Climbing grade (UIAA) | 8.2 (0.56) | 7–9 |
| Climbing training (hours per week) | 5.9 (3.3) | 1–14 |
| Regular climbing (months) | 26.3 (16.9) | 10–84 |

Table 1: Characteristics of the 29 climbers
[1] skinfolds, see Ref. [20]

| | Group 1 (pain) | Group 2 (no pain) |
|---|---|---|
| number | 21 | 8 |
| symptoms | | |
| swelling of the finger joints | 5 | 0* |
| morning stiffness of the fingers | 7 | 2 |
| paresthesia in fingers or hands | 3 | 1 |
| clinical signs | | |
| swelling of the finger joints | 5 | 0* |
| laxity flexor system | 2 | 2 |
| radio-ulnar instability | 6 | 4 |
| hyperextension PIP[1] | 7 | 3 |
| hyperextension DIP[2] | 7 | 2 |
| reduced range of motion in PIP/DIP joints | 0 | 0 |
| bowstringing of the flexor tendons | 3 | 0 |
| radiological signs | | |
| possible epiphysiolysis | 4 | 1 |
| pathology in MRI | 3 | 0 |

Table 2: Reported symptoms and pathological findings in the fingers of young elite rock climbers
[1] PIP = proximal interphalangeal joint of the finger
[2] DIP = distal interphalangeal joint of the finger
* $p < 0.05$

The climbers were also asked about specific symptoms that might indicate overuse injuries of the fingers and hands such as pain, morning stiffness, swelling, paresthesia, and flexion and/or extension deficits of the finger joints.

There were no intergroup differences in age, body weight, lean body mass, grip strength, laxity score, climbing difficulty, amount of training, increase in climbing difficulty per year, age when climbing was started, regular one-finger climbing or warming up before training or competition, capsular thickening and radio-ulnar instability of the finger joints and the Beighton score. Neither the clinical symptoms such as swelling, morning stiffness, parestesia, nor the clinical findings such as swelling, laxity, instability, hyperextension or range of motion deficit of the affected finger joints, or bowstringing of the flexor tendons could differentiate between group 1 and 2. Only swelling of the affected finger joints was significantly more prevalent in group 1 (chi-square, $p < 0.05$).

## Discussion

In adult elite climbers a high rate of hand and finger injuries has been reported [1, 2, 3, 4, 6, 7, 8, 9, 10, 12, 13, 14, 19]. Similarly, we had a total of 21 injuries among 29 10- to 17-year-old elite rock climbers. Although inspection of the fingers revealed many abnormalities, these did not correlate with injury or pain. Signs such as capsular thickening of the finger joints or radio-ulnar deviation and hyperextension of the PIP joints are apparent in a majority of climbers and may be considered more adaptive than pathological.

Lateral instability and hyperextension of PIP and DIP joints have not been described among adult climbers. We know from other sports that joint laxity diminishes with maturity [22]. Considering the whole body, this inherent hypermobility of the prepubescent and pubescent climber is without a doubt an advantage for climbing. Nevertheless it might be a risk factor for injury in the fingers [23]. Hypermobile PIP joints were also found in all the adolescent climbers who were shown to have an epiphysiolysis of the PIP joints in the study by Hochholzer et al. [19]. However, their statement that the climbers with generally hypermobile joints would be more prone to overuse injuries such as tendovaginitis or increased joint fluid, was not supported in our study.

No major injuries such as pulley tears, tendinitis or tendovaginitis [1, 2, 3] which have been reported in the adult climbers have been detected among the young climbers. None of the climbers had evidence of an acute epiphysiolysis as decribed by Hochholzer et al. [19], who described significant hyperdensity of the epiphysis with notched extensions in the radiographs taken 6 months after the epiphysiolysis. Interestingly, some of our climbers also demonstrated various degrees of hyperdensity of the epiphysis, sometimes without a history of previous injury. Nevertheless, hyperdensity of the epiphysis has been reported to be normal [24, 25].

Climbers as young as 20 have been found to have radiographic signs of osteoarthritis in the finger joints [26]. None of our climbers demonstrated any evidence of osteoarthritic or even pre-osteoarthritic changes despite a climbing history of up to 7 years. Their climbing careers have probably been too short for such detrimental changes in the joints. A possible explanation for the low prevalence of severe finger injuries might be explained by the training technique. The adolescent climbers generally avoid finger strengthening with additional weights, hanging on single fingers and using small ledges.

Training at a young age should be performed in a playful way including different sport activities. Difficult routes may be overhanging, but should have large grips in order to prevent the crimp grip position of the fingers. We believe that specific routes for children and adolescents should be built by experts with the use of ergonomic grips.

We found both adaptive and pathological effects in the fingers from climbing. Heavy loads during climbing lead to adaptive soft-tissue changes of the hand, usually affecting the subcutaneous structures and the capsules of the finger joints. Two-thirds of all climbers had experienced climbing injuries or finger pain after an average climbing career of not more than two years. We did not detect tendinitis or epiphysiolysis. It is possible that apparent adaptive tissue changes might be a precursor of later injury. Further research is required to distinguish normal adaptive processes from pathological tissue changes after climbing. Trainers, parents and medical professionals should be aware of the symptoms of pain, swelling and a restricted range of motion of the finger joints. MRI examination does not seem to be indicated initially. Clinical examination with radiographic imaging should be performed because treatment or a change in training regimen to prevent pending injury might be indicated.

## Acknowledgments

We would like to thank B. Marti, B. Stiasny, M. Knobloch, G. Eich, G. Sigrist Madlener and K. Zafren for their valuable help in the study. We also thank the Institute of Sports Science, Federal Office for Sports, Magglingen, Switzerland for their generous financial support.

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