Rock and Ice-Climbing Medicine

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10.1 Introduction

Rock and ice climbing diversified from mountaineering with various forms of activities, such as sport climbing or deep water soloing. The overall climbing performance is depending on psychological factors (e.g. finger strength, BMI), mental capability and technique. Climbing sports can be performed from a young age up to a very advanced age. The overall injury rate is low, with most injuries being of minor severity. Nevertheless the risk of a fatal injury is always present. Both injury rate and fatality rate vary from the different subdisciplines performed and are the lowest for indoor climbing, bouldering or sport climbing. They are naturally higher for alpine climbing or free solo climbing. External factors as objective danger through, e.g. wind chill or rockfall add to the risk. Most injuries and overstrain are on the upper extremity, mostly at the hands and fingers. Climbing is known to be beneficial for both the musculoskeletal system and the mind. It is used in physical therapy, behavioural training and similar social integrational activities.

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10.2 Definition

Rock climbing originated from mountaineering but diversified within the early 1980s. As originally the main goal was just to reach the top, climbers in the Yosemite Valley in the United States and in the Elbsandstein in Eastern Germany started a different approach and tried to climb the hardest possible way without using technical aid [1]. The idea of "free climbing" was born. Its popularity spread globally and diversified to include new categories like ice climbing, bouldering, speed, pure aid climbing and deep water soloing. Simultaneously in mountaineering the routes to reach the summit became more and more difficult and extreme. Nowadays outdoor and indoor competition climbing are also very popular [2], but as this book focuses on extreme sports we will only focus onto outdoor climbing activities.

With any sporting participation, there will be some risk of injury that must be weighed against the benefits of this exercise. To date no known study has demonstrated that rock and ice climbing in general are high-risk sports [3, 4], a commonly held perception. Nevertheless extreme

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alpine climbing or solo climbing certainly qualifies.

Epidemiological analysis of sport-specific injuries helps inform preventive measures that can target the incidence and reduce their severity. Extensive studies on injuries in general rock climbing, indoor climbing and competition climbing exist, including analysis of the injury risk per 1000 h [5–28]. Most injuries in rock climbing occur on the upper limbs, notably the fingers, and are generally a result of overstraining rather than acute injuries [29].

10.2.1 Various Types of Climbing and Main Techniques

Rock climbing is a multidisciplined sport. Depending on the subdiscipline, the climber's experience and skills, grade of route's difficulty, equipment, climbing surface, remoteness of location, altitude and weather will implicate different levels of risk and difficulty. In addition to these variables, many climbers regularly participate in more than one climbing subdiscipline.

10.2.1.1 Sport Climbing

Sport climbing or free climbing requires gymnastic-like strength, flexibility, finger strength and strength endurance when climbing each unique and graded route. The climbing is slightly prescriptive as the climber ascends towards mostly permanently fixed anchors, such as bolts, to clip their rope into for protection. Falls are frequent, trained for and are mostly harmless. Physical hazards (rockfall, weather changes, etc.) are small, and the neglect of wearing a climbing helmet is widely accepted [3, 4, 30] (Fig. 10.1).

10.2.1.2 Bouldering

Bouldering consists of ropeless climbing involving a short sequence of powerful and technical moves to complete the graded route on large rocks. Bouldering can be done without a partner and with minimal equipment – climbing shoes and crash pad. Falling onto one's feet or body is a normal part of bouldering, whether a route is completed or not [4, 30] (Fig. 10.2).

10.2.1.3 Deep Water Soloing

Deep water soloing (DWS), also known as "psicobloc", is solo rock climbing, practised on sea cliffs at high tide, that relies solely upon the presence of water at the base of a climb to protect against injury from falls. These routes can be up to 20+ metres high, and lately some of the hardest climbs in the world have been established in that styles (e.g. Chris Sharma, Es Pontàs, Spain) (Fig. 10.3).

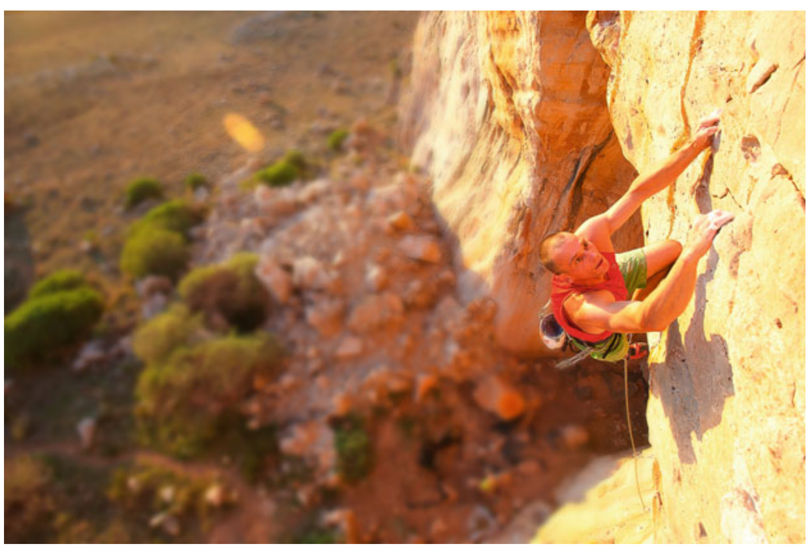

Fig. 10.1 Sport climbing

Fig. 10.2 Bouldering

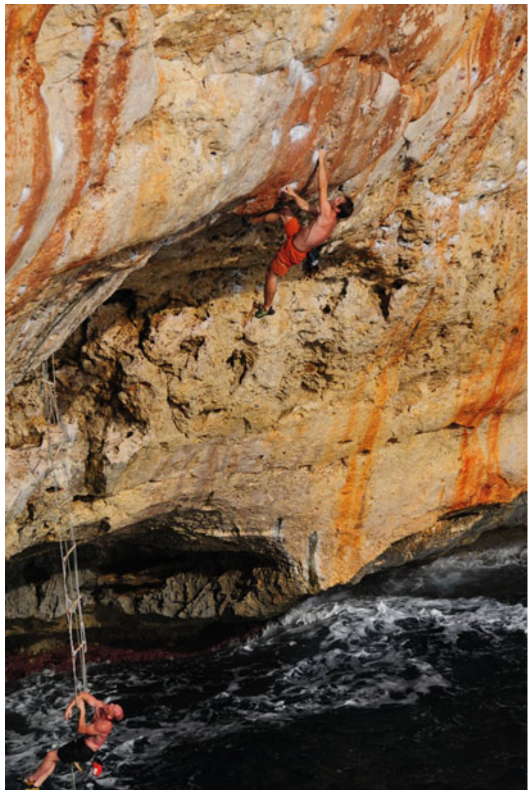

Fig. 10.3 Deep water soloing

10.2.1.4 Traditional Climbing

Traditional (alpine) climbing (or *trad climbing*) emphasises the skills necessary for establishing routes in an exploratory fashion outdoors. The lead climber typically ascends a section of rock while placing removable protective devices where possible along the climb. Falls can therefore be longer than those experienced when sport climbing. Unreliable fixed pitons may occasionally be found on older established routes. As physical hazards are likely, the use of a helmet is considered mandatory. Above around 2500 m, psychological altitude-induced adaptations must also be factored into the climbs [4, 30] (Fig. 10.4).

Fig. 10.4 Alpine climbing

10.2.1.5 Indoor Climbing and Competition Climbing

Indoor climbing and competition climbing are performed on artificial structures that try to mimic climbing outdoors but in a more controlled environment. As physical hazards are almost totally eliminated, such climbing became an

Fig. 10.5 Competition climbing

Fig. 10.6 Ice climbing

extracurricular sport in many countries. National and international competitions are held on such walls and involve three major disciplines – lead climbing (i.e. sport climbing), speed and bouldering. Indoor bouldering is performed above thick foam mat flooring [4, 30] (Fig. 10.5).

10.2.1.6 Ice Climbing

Ice climbing normally refers to roped and protected climbing of features such as icefalls, frozen waterfalls and cliffs and rock slabs covered with ice refrozen from flows of water. Equipment includes ice axes for hands and crampons for feet. Physical hazards like avalanches, rock and icefalls are present [4, 30, 31] (Fig. 10.6).

10.2.1.7 Free Solo Climbing

In contrast to the public perception, real free solo ascents are rare and don't play a major role in the current climbing sports. Nevertheless if performed they usually get a high media attention, thus mimicking a higher prevalence. The injury and fatality risk is obviously high.

10.2.2 Main Psychological and Anthropometric Characteristics

Based on the fact that climbing is not a cyclic but a poly-structural sport, it is difficult to evaluate the performance-limiting factors, of which many are still not verified [32–36]. One important factor is the anthropometric profile of the athletes, which was subject of a few studies of general climbers and elite competitors in lead climbing (sport climbing) [32, 37–41]. In the scientific literature climbers are described as being relatively small in stature and having a very low percentage of body fat [32]. Unexpectedly, their hand grip strength measured via dynamometer does not differ from non-climbers, because of the nonspecific

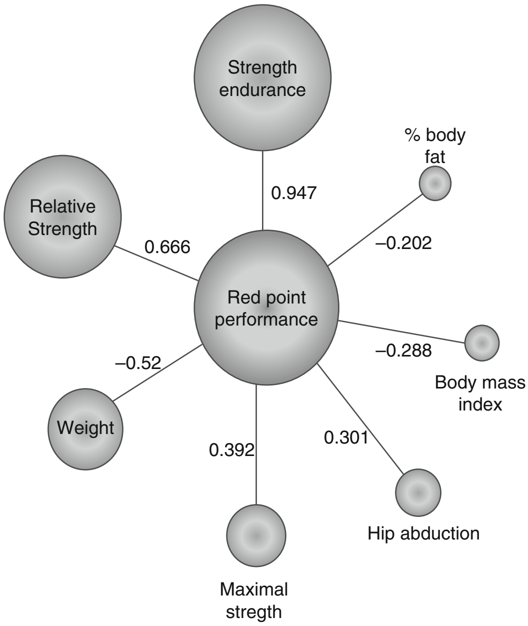

Fig. 10.7 Correlations between the red point achievements and some of the factors of performance, Michailov (2006) [43]

grip position in this test [36, 38–40]. Elite climbers are also stronger with the left hand (which is more often the nondominant hand) than recreational climbers and non-climbers [38]. The reason is probably connected to the fact that climbing develops strength and agility for both hands [32]. Many components have been proposed which correlate with the overall climbing performance [32, 33, 36]. However, some authors have proven the major importance of the specific strength endurance in sport climbing with strong correlation coefficients [42–44]. More recent studies support the fact that rock climbing requires harmoniously developed physical fitness, technical and tactical skills, as well as mental preparation [43] (Fig. 10.7).

10.2.3 Psychological and Behavioural Characteristics

The psychological and behavioural characteristics of any climbing subdiscipline are rarely studied, though they are a key performance variable that may additionally have an influence on injuries and fatalities sustained [46–48]. It is generally accepted that those rock climbers high in self-efficacy participate more frequently, take calculated additional risks and attempt harder climbs when they feel confident in their abilities, though this is rarely studied [4, 46].

10.3 Benefits from This Sport

Learning to climb has never been easier with the advent of indoor artificial climbing walls found in many cities [20]. In some schools it even forms part of the sport curriculum [1, 49]. Rock climbing participation is accessible at all ages, toddler to pensioner [1, 33, 49, 50], and is enjoyed by many over a lifetime. In a recent study we analysed our climbing patients between 2009 and 2012, where we saw climbers between a range of 11–77 years of age and 0.3–64 years of climbing [51]. Climbing sport is a lifelong activity with many health benefits, e.g. musculoskeletal training, equilibrium and mental training as well as minor injury risk [1]. Both genders can easily climb together and perform at an even level [1]. Its potential in rehabilitation and physiotherapy is widely used, as well as in behavioural training and social rehabilitation programmes [52–55].

10.4 Acute Injuries and Fatalities

Extensive studies on injuries in general rock climbing [1, 3, 4, 14, 15, 18, 21, 28, 56–65], indoor climbing [6, 18, 20, 24] and competition climbing [8, 49] exist, including analysis of the injury risk per 1000 h. Severe injuries during indoor or competition climbing are rare, but do happen [14, 15, 18–24, 27, 28, 49, 61, 64, 66–71]. Most injuries in rock climbing occur on the upper limbs, notably the fingers, and are generally a result of overstraining rather than acute injuries [19, 29, 69, 72–76]. Nevertheless in some studies more lower limb injuries are found [6, 11, 65]. Most injuries involve fractures, sprains and dislocations [3, 19, 28, 65, 76]. To date no known study has objectively demonstrated that ice and rock climbing are high-risk sports or that those climbing higher grades are more prone to experience severe injuries compared to those climbing lower grades. Nevertheless the media's lurid depiction of elite rock and ice climbers has helped to create a perception of climbing as being a hazardous and high-risk sport [77, 78]. For example, a 1999 *Time Magazine* cover featured a sport climber with the headline "Why we take risks" with a subtitle stating "From extreme sports to day trading thrill seeking is becoming more popular" [78].

To objectively analyse and compare injuries from different sports, a common scoring system for the grading of the injuries is essential. In general, when assessing whether a sport presents a high risk of injury or death, a distinction between overstrain (overuse) injuries and acute injuries or accidents should be made [4]. The reason is overstrain injuries are generally less severe and can generally be avoided with informed training, whereas an examination of the injury rate for acute sport-specific injuries, especially their severity, is crucial.

Most authors [5, 10, 11, 65, 76, 79] found that fractures, strains and sprains account for most injuries. Schöffl et al. [76] found the most common climbing injury the closed pulley rupture and the most common overuse injury the tenosynovitis of the finger flexor tendons. These pulley injuries are almost rock climbing-specific pathologies and matter of extensive research [60, 80–85]. Overall the majority of all injuries in the studies on outdoor and alpine climbing as well as bouldering studies were of minor severity (UIAA MedCom 1-2) [10, 15, 28, 60, 62–64, 70, 86].

Few studies examined ice-climbing injuries and overuse syndromes. In our study [31] we found that most of the acute injuries (61.3 %) occurred while lead climbing, 23.8 % while climbing second, and the rest was rare (6.3 % belaying, 3.8 % on return and 2.5 % on approach, other 2.5 %). Most of the acute injuries (73.4 %) happened in a waterfall, few in glacier ice walls (11.4 %) and on artificial ice walls (2.5 %). Climber fall-related acute injuries amounted for 10.5 %.

As there was an inconsistency in the use of scores for climbing studies and thus a lack of inter-study comparability, the Medical Commission of the UIAA (International Mountaineering and Climbing Federation) gave a consensus statement on injury and illness definition in mountain sports and proposed a new UIAA MedCom-Score88, which showed its value already in recent studies by Neuhof et al. [79] and Schöffl et al. [6]. The UIAA MedCom Score uses the OSICS 10 [88–90] tables for injury distribution and a new classification (Table 10.1). In addition a fatality risk classification and guidelines to evaluate a time-related injury risk are given [87].

Table 10.1 UIAA MedCom Score 2011 [87]. Injury and Illness Severity Classification (IIC) – UIAA MedCom Score

Score	Description
0	No injury or illness
1	Mild injury or illness, no medical intervention necessary, self-therapy (e.g. bruises, contusions, strains)
2	Moderate-severe injury or illness, not life threatening, prolonged conservative or minor surgery, outpatient therapy, doctor attendance within a short timeframe (days), injury-related work absence, heals without permanent damage (e.g. undisplaced fractures, tendon ruptures, pulley ruptures, dislocations, meniscal tear, minor frostbite)
3	Major injury or illness, not life threatening, hospitalisation, surgical intervention necessary, immediate doctor attendance necessary, injury-related work absence, heals with or without permanent damage (e.g. dislocated joint, fractures, vertebral fractures, cerebral injuries, frostbite with amputations)
4	Acute mortal danger, polytrauma, immediate prehospital doctor or experienced trauma paramedic attendance if possible, acute surgical intervention, outcome: alive with permanent damage
5	Acute mortal danger, polytrauma, immediate prehospital doctor or experienced trauma paramedic attendance if possible, acute surgical intervention, outcome: death
6	Immediate death

10.4.1 Fatalities

While some forms of rock climbing, such as solo climbing or alpine traditional climbing and clean climbing, show a larger injury risk, indoor and bolted sport climbing proved to be relatively safe [3, 4, 10, 12, 13, 18, 20, 65]. Nevertheless there is still a risk of a fatal injury. Few studies give exact data on a fatality rate, as many are conducted retrospectively. Statistics of the German Alpine Association reported seven deaths in the years 2006 and 2007 [91]. These statistics do not differentiate between traditional, ice and sport climbing. A retrospectively conducted study on mountaineering overall calculated an incidence of 0.13 fatalities per 1000 h [63]. For alpine climbing (traditional climbing), a death rate (fatality rate) was documented by Bowie [28] – 13 from 220 injured climbers died – a case fatality rate of 6 %. As most of analyses done in these climbing injury studies were conducted retrospectively through questionnaires, the fatality rate is frequently biased. The "older" studies (20 years ago) [28, 63, 64] reported the most severe injuries and the highest fatality rates, while recently a prospectively conducted study on bouldering [12] reported no fatalities.

The general death numbers in ice climbing can be analysed through the injury and fatality reports of the various Alpine clubs [31]. The Canadian [92] and the American Alpine Club [93] have statistically recorded and analysed all mountain accidents since 1951. In the USA, up to the year 2005, there were 6111 accidents with a total of 1373 (12 %) fatalities [93]. Two hundred fifty-four (4 %) of the accidents happened in ice, though no further evaluation of the ice-climbing injuries was given. Nevertheless if 4 % of all injuries are to be accounted to ice climbing, also 4 % of the deaths can be assumed to be related to ice climbing. This would calculate to 55 fatal ice-climbing injuries in 54 years, in average one ice-climbing fatality per year within the USA. The numbers for Canada are similar [92]. Over 30 years, 92 mountaineers were injured while ice climbing, 30 fatally. Overall the major ice-climbing countries, Switzerland and Canada, report about one death per year [92, 94]; nevertheless these numbers were rising in recent winters [31]. This is probably due to the fact that ice climbing itself became much more popular. For further understanding the UIAA MedCom also published a fatality risk classification [87] (Table 10.2).

Table 10.2 Fatality risk classification (FRC) (UIAA MedCom [87])

Class	Description
I	Fatalities are technically possible, but very rare. No objective danger, e.g. indoor climbing
II	Few objective dangers, fatalities rare, falls are not very dangerous, risk is mostly calculable – e.g. sport climbing, low elevation and technically easy peaks
III	High objective danger, risk is difficult to calculate, falls lead frequently to injuries, fatalities more frequent – e.g. traditional climbing, high Himalayan (7000–8000 m) or difficult peaks
IV	Extremely dangerous, falls have a high fatality rate, totally unjustified to normal mortals

10.5 Overstrain Injuries

Chronic overuse injuries occur most often on the upper extremities at the elbow and the fingers [15, 76, 79]. As hand and finger injuries are the most common injuries [1, 29, 60, 95], many studies focus on these anatomical regions [16, 29, 57–60, 69, 76, 95–99]. Schöffl et al. [51, 76] found over 10 years the most common climbing injury being the closed pulley rupture and the most common overuse injury the tenosynovitis of the finger flexor tendons. These pulley injuries are almost rock climbing-specific pathologies and matter of extensive research [60, 80–85]. Other finger injuries which are climbing specific are the "lumbrical shift syndrome" [100], "extensor hood syndrome" [101], "epiphyseal fractures" [75], "FLIP-syndrome" [102], "finger amputations – rope tangling injuries" [57], M. Dupuytren in young age [103] and osteoarthritis of the fingers [58, 104, 105]. In recent publications back problems ("climbers back" [106]) and shoulder pathologies (SLAP and biceps tendon tears [56, 107, 108]) as well as feet deformations were evolving [5, 109–111].

In ice climbing overstrain injuries are rare and hard to distinguish from other climbing training in its origin, as few climbers only practise ice climbing [31].

10.6 Diagnosis and Therapy of the Most Important Conditions

10.6.1 Pulley Injuries

Injuries to the finger flexor pulley system are the most common finger injuries in rock climbers [60]. The pulley system of the second to fifth

Table 10.3 Therapy guidelines for annular pulley injuries [60]

	Grade I	Grade II	Grade III	Grade IV
Injury	Pulley strain	Complete rupture of A4 or partly rupture of A2 or A3	Complete rupture of A2 or A3	Multiple ruptures, as A2/A3, A2/A3/A4 or single rupture (A2 or A3) combined with mm. lumbricalis or ligamental trauma
Therapy	Conservative	Conservative	Conservative	Surgical repair
Immobilisation	None	10 days	10–14 days	Postoperative 14 days
Functional therapy	2–4 weeks	2–4 weeks	4 weeks	4 weeks
Pulley protection	Tape	Tape	Thermoplastic or soft cast ring	Thermoplastic or soft cast ring
Easy sport-specific activities	After 4 weeks	After 4 weeks	After 6–8 weeks	4 months
Full sport-specific activities	6 weeks	6–8 weeks	3 months	6 months
Taping through climbing	3 months	3 months	6 months	>12 months

finger consists of five annular (A1-5) and three cross (C1-3) ligaments (pulleys). Caused mainly through the crimping position, the A2, A3 or A4 pulleys, which are considered the most important ones, can either be strained or ruptured. The most frequently injured pulley is the A2 pulley.

Mostly the climber reports of an acute onset of pain while crimping on a small edge [30]. Sometimes a loud "snapping" sound can be heard. The climber complains about palmar-sided pain at the level of the injured pulley, pressure tenderness, swelling and rarely haematoma. The pain can extend into the palm or the forearm. After clinical suspicion and exclusion of a fracture via radiograph, ultrasound examination leads to its detection. If multiple pulleys are ruptured, a clinical "bowstring" becomes visible. With the ultrasound an enhanced distance of the flexor tendons to the phalanx (tp) can be observed. If the ultrasound fails to give an exact diagnosis, an MRI should be performed. Based on a grading system and an algorithm proposed by Schöffl et al. [60], single ruptures receive a conservative and multiple ruptures a surgical therapy. Biomechanical analyses and strength measurements after conservative pulley ruptures of single pulley injuries proved no strength deficit of the injured finger, and the climbers gained their original climbing level back after 1 year. The outcome after surgical repair of multiple pulley injuries is also good, with mostly a full regain of climbing ability. Nevertheless often a minor restricted range of motion is persisting [112]. After pulley injury a protective taping with the biomechanical developed H-tape is recommended [30, 113] (Table 10.3, Fig. 10.8).

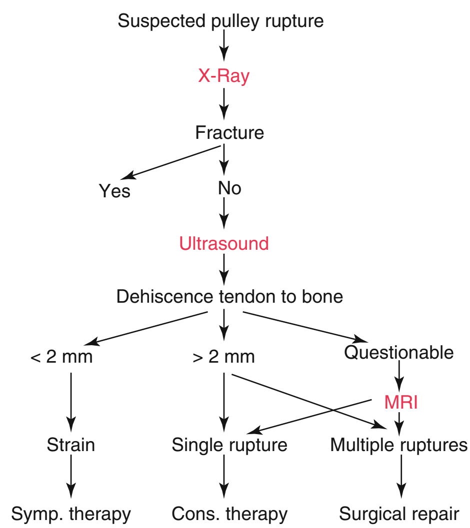

Fig. 10.8 Diagnostic-therapeutic algorithm in suspected pulley injury [60]

10.6.2 Tenosynovitis

Tenosynovitis is the most important differential diagnosis to the pulley injury and the most frequent overuse syndrome in climber's fingers

[1, 30, 51]. An inflammatory response occurs after repetitive stress, and its onset can be acute, after one exceptional hard training or climbing day, or slow over days. The climber has pain and minor swelling along the palmar surface of the digit, just around the same area as in a pulley injury [51]. The pain can extend into the palm or the forearm. The diagnosis can be proven through ultrasound, which detects a "halo" phenomena around the tendon [29, 51, 76]. This increased gathering of liquid around the tendon becomes best visible in a transversal plane. As climbers tend to have increased liquid in their flexor tendon sheets after high stress on various ranges, no clear information can be given about the normal range [51]. It is best to compare the ultrasound finding of the injured finger to the same one of the contralateral side. The therapy consists of anti-inflammatory medication, resting on a splint for several days, externals, brush massages, ice therapy and in a persisting condition local cortisone injection. Sometimes these injections are not avoidable as the chronic tenosynovitis can be stubborn [1, 51].

10.6.3 Fractures, Epiphyseal Fractures

They are mostly caused by direct trauma as rockfall or hiding the rock, while fall fractures occur in all varieties [1, 51]. Another injury mechanism is a jammed hand or finger in a crack or pocket and through non-axial forces or bending the finger an indirect trauma. Those fractures need to be treated according to trauma/orthopaedic surgical standards. Note that some minor fractures can present with the clinical symptoms of a pulley rupture; thus in suspicion of a pulley rupture an x-ray to exclude a fracture should be performed [1, 51]. Alarming is the rising number of epiphysiolyses and epiphyseal fractures of young climbers with no trauma [29, 51, 75, 114, 115]. Thus they need to be considered as fatigue fractures. The radiographs mostly show Salter-Harris III fractures of the dorsal part of the epiphysis of the PIP joint, which can be directly linked to using the crimp position. All patients reported about a slow onset of pain, and no real trauma was involved. They complained about pain at the interphalangeal joint in combination with swelling. If a standard radiograph shows no pathologic finding, an additional MRI is mandatory [29, 51, 75, 114, 115]. Those injuries need to be treated strictly; otherwise irreversible damage will be the result. In non-dislocated fractures and epiphysiolysis, conservative therapy with cast, splinting and stress reduction needs to be performed. If a dislocation is found, a surgical retention must be performed.

10.7 Equipment and Prevention

10.7.1 Injury Prevention

Injury prevention can be done from both sides, the climbers and the climbers' body, the UIAA (International Mountaineering and Climbing Federation) and the respective countries' Alpine clubs. The following bullet points can be or were already largely improved [1, 51]:

- Crash pad and spotting in bouldering
- Mats in indoor climbing
- Closure of mat gaps
- Route setting outdoors
- UIAA Safety Label
- Belay technique
- Fall technique

In bouldering a "crash pad" and a spotter should be used [1, 51]. A "crash pad" is a foldable mat with a thickness of about 10–15 cm which is positioned underneath the climber. These mats are widely used and are together with spotting the reason that in bouldering not more injuries occur than in roped climbing [1, 51]. Also a partner serves as a spotter in bouldering, which means he helps to position the falling climber in an erect position and onto the mat. Without running into the discussion, if climbs should be bolted or climbed free with jamming devices, in bolted routes, a general common sense on where to place the bolts is important. The bolts should not be so far apart that a ground fall is possible and always at a point where they can be clipped by smaller climbers as well. The UIAA safety commission gives safety labels (seals) to safetyapproved equipment and only such equipment should be used. They perform intensive research on injury mechanism and avoidance of technical failures, e.g. in belay devices. A good belay and fall technique must be trained, so that the belayer does not catch the fall too statically, leading to a high impact of the climber hitting the rock. The same applies for learning how to best fall and which position in the fall is the safest [1, 6, 51].

10.7.2 Equipment

At the beginning of climbing, classic heavy mountaineering boots were worn for climbing in alpine regions as well as in rock faces [1, 51]. Only in the early 1980s, the first real climbing shoe with a friction sole entered the market. A characteristic that all climbing shoes have in common is the fact that they will have to be worn very tight in order to get an optimal contact to the rock, which will often lead to health problems, such as callosity, toe nail infections or in a longer time perspective a hallux valgus deformity. The introduction of bolts was an important factor for the explosive development of the climbing grades achieved. Falls into the rope are common for sport climbers now [57]. The climbing harnesses have also changed essentially. While a combination of chest and sit harness has been used in traditional mountaineering, a pure sit harness is deployed in sport climbing [57, 86]. This will allow an injury-free falling with maximum free movement while climbing. Bolts, ropes, harnesses and other equipment used should have the UIAA safety commission's approval [1, 51]. Also ice-climbing equipment developed a long way from the tools used in classical mountaineering. Modern crampons with the prominent frontal spikes have become standard. Nowadays a single frontal spike and even heel spurs are state of the art [31]. Ice axes have witnessed a transformation of long-shafted ice axes into a short-shafted curved cross-bar that looks like an assault weapon [1, 51]. It is widely discussed and hotly debated in the ice-climbing community whether ice axes should be used with or without leashes [1, 31, 51]. Leashes, which do reduce the stress onto the forearms, can increase the risk of injuring oneself during a fall, as they attach the ice axes to the body. In parallel with the technological advancements in crampons and ice axes, Erich Friedli from Switzerland developed the first real ice screws [1, 51]. These ice screws have played a pivotal role in increasing the safety of the sport. These screws guarantee a comparable pull-out strength to bolts if placed in good ice and at the correct angle [31]. Again, all of the used equipment should be UIAA proven.

Conclusion

Rock and ice climbing are fascinating sports which can be performed from childhood to an old age. They guarantee a full body workout together with mental, psychic and body awareness training. The injury rates are low, and most injuries of minor severity. Nevertheless fatalities do occur and proper training, equipment and precautions are necessary to reduce these risks. Partner check and redundancy are sequences from climbing similar to aviation and play lately a role in medical processes as well [116]. In outdoor climbing environmental factors and objective dangers as weather conditions, snow, rock- and icefall, etc., increase the injury risks. Appropriate preventive measures can reduce these risks.

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