COLLECTIVE REVIEW

Orthopedic problems in sport climbing

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Sport climbing is associated with unique upper- and lower-limb injuries involving predominantly the hand, elbow, and shoulder, and to a lesser extent the foot. Many pathologic conditions are limited to sport climbing. Physicians treating sport climbers should be aware of these unique injuries and overuse syndromes. This article presents an overview of orthopedic problems (injuries, overuse syndromes, and fractures) resulting from sport climbing. Sport climbing is defined in the context of existing mountain sports, and its characteristics and technical terms are presented. The etiology, diagnosis, and specific treatment for orthopedic problems associated with sport climbing are described.

Key words: mountaineering, climbing, sport climbing, injuries, overuse injuries, hand, upper extremity

Introduction

Mountaineering and climbing changed in the sixth and seventh decades of the 20th century, when young, dynamic athletes became more interested in the nature and character of the routes they were climbing and in the way (ethical code) they tackled these routes than in simply getting to the top. These routes did not necessarily lead to a summit; often they were only a few pitches long. The pitches grew more and more difficult as more climbers discovered this aspect of mountain sports. The parallel development of high-tech materials and maximal training by these elite athletes pushed the limits in sport climbing, as the new entity was called, from the existing Union Internationale des Associations Alpinistes (UIAA) degree VI to UIAA degree XI.

This new entity with special training and competition patterns eventually produced its own specific group of injuries and overuse syndromes, mostly localized to the upper extremity. The pathogenesis and diagnosis of these orthopedic problems is described, and selected treatments and rehabilitation programs specific to sports climbing are discussed.

TERMINOLOGY

Classic alpine climbing is characterized by approaches that are sometimes long and difficult in an alpine envi-

ronment, multiple pitches, and routes leading up exposed walls with alpine dangers that reach an actual summit. Short, often single-pitch routes of high difficulty typify sport climbing. The climbs may be made on smaller rock formations (climbing gardens) or on artificial climbing walls with specifically designed handholds and footholds. Often the belay points are cemented bolts or other permanent placements that provide very safe climbing. Sports climbing on artificial walls has been spurred on by competition to determine the fastest climber on routes of varying difficulty.^{1–3}

Sport climbing can be considered the latest evolution of free climbing, which was developed in Yosemite National Park in the 1960s. Free climbers use only natural rock formations. Artificial aids such as ladders or pegs are not acceptable except to put up belays and runners. (They still are used as climbing aids in technical [artificial] climbing of routes without adequate natural holds.) Free climbing does not imply climbing without a rope: free climbers do protect themselves from falls. Climbers who do not use a rope are considered to be *free soloing*. *Bouldering* is the term given to free soloing small rock formations without climbing above a height from which the climber can still jump without injury. A new development in this entity is special mattresses laid at the bottom of a rock face or indoor climbing wall; these allow softer touch-down when jumping (and new heights for bouldering).^{1–5}

CHARACTERIZATION

Sport climbing is a rapidly evolving sport that is enjoying more and more popularity because safety and climb-

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ing equipment are being improved and the number of artificial climbing walls is growing. Climbers can exercise in complete safety and in all weather conditions without having to access a climbing area. Training programs can be scientifically developed and evaluated without being dependent on outdoor conditions, and modern training concepts can be employed. Extensive media coverage on television and now also on the Internet has increased public interest in this aspect of "mountain sports."

In sport climbing, climbers attempt increasingly difficult routes that have smaller footholds and handholds and are often overhanging. The handholds and footholds may be as thin as a tiny lip or protrusion of the rock and only wide enough to take 1 or 2 fingers. Moves sometimes are dynamic, and jumping is necessary to reach the next hold. In contrast to traditional climbing, in which the lower extremities support most of the body weight, in sport climbing the upper extremities do most of the work on difficult routes. Great upper body strength, which can be obtained only through specific training of the forearms and hands, is required. In addition to strength, in sport climbing weight distribution and body positioning require the grace of a ballet dancer for precise, smooth movements.¹⁻⁹

Injuries in traditional rock climbing result mostly from falls or falling objects. In general, mountaineering injuries may also be produced by the environment, particularly snow and ice during long approaches or expeditions, resulting in another spectrum of medical problems.^{1,10-21}

In sport climbing, because maximal power and endurance is required of the upper extremities, they are the major site of injuries and overuse syndromes. Many reports have described the leading role of hand and finger injuries among the medical problems of the upper extremity. Those injuries primarily involve the slowly adapting tissues—ligaments, tendons, and joint capsules—rather than more rapidly adapting muscle tissue. In addition, long-term problems such as nail dystrophy and foot deformities are seen in climbers who climb very often and on very difficult routes.^{4,5,7-9,22-53}

Overuse syndromes and soft tissue injuries

UPPER EXTREMITY

High stress and repetitive stress injuries constitute the major injury pattern in sport climbing. About 75% of sport climbers eventually suffer upper extremity overuse syndromes or injuries because of the emphasis on vertical and overhung climbs on artificial walls. The most commonly involved structures are the fingers and the

Figure 1. Crimp grip, lateral view: hyperextension of the distal interphalangeal joints and hyperflexion of the proximal interphalangeal joints of the hand.

wrist, where 60% of the injuries occur. The other 40% is equally divided between the elbow and the shoulder.^{7,19,24,25,54}

Hand and fingers

Overuse and unphysiological use (extreme shear stress) can damage all structures of the finger joints, particularly cartilage, in specific positions. Both the proximal interphalangeal joint (PIP joint) and distal interphalangeal joint (DIP joint) can be injured, although the PIP joint is most often involved. The joint positions that most often lead to injuries are hyperextension of the DIP and hyperflexion of the PIP joint, a position taken mostly on quite small handholds. This position is called *crimping* in the UK, *cling grip* in the United States, and *position archée* or *prise en graton* in France (Figures 1 and 2). Early morning stiffness and fine motor deficits are the first symptoms of overuse. In chronic cases, signs and symptoms include capsular swelling, pain on pressure

Figure 2. Crimp grip, top view: hyperextension of the distal interphalangeal joints and hyperflexion of the proximal interphalangeal joints of the hand.

and movement, and in some cases even instability. Up to 15° fixed-flexion deformities of the PIP joints can develop bilaterally. They are most common in the ring and middle fingers but are occasionally seen in the index or little fingers. This positioning of the joint is caused by adoption of a rest position after heavy exercise and can be prevented only by active stretching of the PIP joints after each training and competition session. Some climbers who participate in the sport for a long time present with irreversible swelling of the finger joints. With magnetic resonance imaging (MRI), adaptive hypertrophy of the collateral ligaments and chronic joint effusions with synovitis are seen. Early degenerative changes consisting of small lateral osteophytes and enlargement of the joint area can be detected in routine radiographs. A significantly higher osteoarthritis score in 2 separate DIP joints and 3 PIP joints was found when radiographic findings in a group of sport climbers were compared with those in a group of nonclimbers.*

*References 5, 9, 13, 24–28, 32, 34, 38, 41, 45, 50, 53, 55, 56.

Because adaptation processes are much slower in tendons, they are especially prone to overuse. The shear forces between the tendon and the tendon sheath, especially when the fingers are crimped on very small holds, can lead to flexor tenosynovitis. Again, the middle and ring fingers are most often involved. Tenderness and swelling over the volar base of the proximal phalanges and the palm indicate flexor tenosynovitis. Ultrasound may disclose fluid around the tendon and in the tendon sheath. With MRI, isolated flexor tenosynovitis can be seen as a circumscribed thickening of the tendon sheath and as increased signal intensity caused by a high fluid content. Furthermore, the flexor tendon lies close to the bone with no fluid intervening between the flexor tendon and the phalanx (in contrast to an injury of the A2 pulley, in which a pathological distance and an extended fluid-rich space may be found between the tendon and the phalanx—see below). A very specific entity is credited for localized pain in the middle phalanx: insertion tendonitis of the flexor digitorum superficialis tendon. The cause is a very intense training program with local overuse.†

To relieve overuse symptoms, partial or complete cessation of climbing and a change in climbing habits are necessary. Whether cessation of climbing is partial or complete is dictated by the severity of tissue damage and the associated signs. Climbing should be reduced to a level appropriate to the existing pathology and then gradually and systematically increased during the rehabilitation process, commensurate with the stage of healing. Active retraining can be started only after full recovery. As even optimal healing produces a scar that is weaker than the original structures, the error in climbing style that produced the original injury must be identified and appropriate changes made. Such style changes include reducing weight bearing and load pulling by the upper extremity and minimization of the use of crimping handholds. In addition, a training schedule with less stress, more rest periods, and extensive stretching exercises must be adopted.

Very severe pain caused by overuse syndromes may require pain and nonsteroidal anti-inflammatory medications, as well as the temporary use of braces or casts, before a basic rehabilitation program can be started. Therapy for severe tenosynovitis may include injection of a dilute water-soluble steroid into the tendon sheath.

A variety of physical therapy techniques can be used. The range of movement, coordination, and power of the hand can be improved by using hand plasticine (plastic substance remaining soft for a long time) or small, soft balls. Prolonged treatment is necessary. When climbing

†References 5, 19, 22, 24–26, 37, 38, 47, 55, 57.

Figure 3. Pocket grip with a single finger flexed in the distal interphalangeal and extended in the proximal interphalangeal joint in a little hole in the rock (here a little hole in an artificial climbing wall hold).

is resumed, special attention must be given to training programs that include long regeneration times. These programs should include specific warm-up methods and stretching exercises that support adaptation and counteract muscle contractures. Not only the climbing agonist muscles (flexors), but also the antagonist muscles (extensors), must be strengthened. Preventive measures after a particularly hard climb also include icing swollen finger joints and taking nonsteroidal anti-inflammatory drugs for 3 days.[‡]

Distortion or rupture of the collateral ligaments of the finger joints occurs when a climber slips or falls while a finger is fixed on a tight 1-finger hold (Figure 3) and high shear forces affect the finger. Clinical examination after such accidents discloses instability of the finger joint. Radiographs may show a bony extraction. Strained or torn collateral ligaments rarely heal well enough to

Figure 4. Pulley system of the middle and ring finger. **A**, Finger in normal extended position with all pulleys A1 to A5 intact. **B**, Finger in crimp grip position (hyperextension of distal interphalangeal joint and hyperflexion of proximal interphalangeal joint) with all pulleys A1 to A5 intact. **C**, Finger in crimp grip position with ruptured A2 pulley and bow-stringing of the flexor tendon.

provide the stability that existed before the injury. This instability can cause joint effusions and cartilage damage. Therapy depends on the severity of the injury. The PIP joint should be splinted at 30° of flexion for an initial period of 1 to 4 weeks. An additional rest period of 1 to 4 weeks should follow. Climbing activity can be resumed after 3 to 6 weeks, but only open-hand grips should be used, and the finger should be taped to stabilize the joint. Chronic joint instability may force the climber to continue taping this finger. Surgical intervention may be necessary to correct severe instability.^{5,25,37,47}

Special attention must be paid to the pulleys of the finger. These dense annular structures (designated A1, A2, A3, A4, and A5) prevent "bow-stringing" of the tendons of the flexor digitorum profundus and superficialis, which are held against the phalanx by a fibrous sheath. The crimp grip (hyperextension of the DIP joints and hyperflexion of the PIP joints) can produce very high forces on the A2 pulley located at the middle of the proximal phalanx. Injuries happen when climbers fall or slip while in this crimp position (Figure 4). A force

[‡]References 5-7, 19, 22, 24-26, 31, 37, 47, 49, 51, 58.

as high as 450 N may suddenly be placed on the A2 pulley. This force is greater than that required to tear this pulley under experimental conditions.

A2 pulley rupture is the most common climber's injury and has been given the name *climber's finger*. The injury is most frequent in the ring and middle fingers because those fingers are used most often for small holds—separately for 1-finger holds and together for 2-finger holds. A loud snap, a feeling of giving way, and acute, severe pain at the base of the proximal phalanx announce the occurrence of the injury. This is usually followed by swelling over the volar aspect of the proximal phalanx and a variable degree of discoloration from bleeding into the tissues. The pain can persist for a few months. With an injury of the A2 pulley, the flexor tendon is bow-stringed to a varying extent across the proximal phalanx when the finger is flexed against resistance. This clinical sign may be very subtle and sometimes is detectable only by comparison with the opposite hand. No direct evidence of a pulley tear can be found with ultrasound or MRI because the pulleys cannot be visualized as discrete structures. Nevertheless, a fairly reliable indirect sign of such injury consists of an extended fluid-rich space with a high MRI signal intensity between the phalanx and the tendon. This increased space between the tendon and the phalanx may differentiate pulley tears from isolated flexor tenosynovitis.

For this injury, therapeutic possibilities range from surgical repair to more classic conservative measures, depending on the severity of the tear as determined by the clinical examination and further diagnostic procedures (ie, MRI). Initially icing, nonsteroidal anti-inflammatory medication, and physiotherapy can be used to reduce inflammation and swelling. For strains or partial tears, such therapy can be continued and early non-weight-bearing mobilization of the PIP joint encouraged. A rehabilitation program including climbing can be started after 2 to 6 weeks. Difficulty, length, and frequency of climbing must be reduced, and climbing techniques must be changed. For severe or complete tears, most authors recommend splinting of the metacarpophalangeal (MP) and PIP joints in slight flexion for 2 to 4 weeks and rest for a subsequent 2 to 4 weeks. Rehabilitation programs must be very slow; a minimum of 2 to 3 months should pass before a return to climbing. Operative treatment is reserved for chronic cases or for combined ruptures of the A2 and A3 pulleys and requires good compliance with a 3- to 6-month postoperative no-climbing regimen to prevent recurrent rupture. Pulley injuries need very careful treatment because the chance of persisting pain is high and can lead to abstinence from climbing for up to 1 year.

No clinical evaluation proves the value of prophylac-

Figure 5. Basic positioning of the upper extremity in sport climbing: forearm pronated, wrist extended in slight ulnar deviation, fingers flexed to gain maximal hold on the rock protrusion. When pulling on to the next handhold, the elbow is flexed by the brachialis and the biceps brachii muscles while the forearm is held in pronated position.

tically taping the fingers (1.5 cm zinc oxide tape around the base of the proximal and middle phalanges), but climbing evidence indicates a reduction in A2 pulley tears. In an experimental setting, 2.5 turns of a 1.5-cm zinc oxide tape tears at a force of 500 N and may help absorb some of the forces to which the tendons and pulleys are subjected in the crimp grip. Taping the base of the proximal phalanx is mandatory for anyone who has suffered an injury of the A2 pulley and is resuming climbing.[§]

Wrist

The most common problem encountered at the wrist (Figure 5) is carpal tunnel syndrome, which is present

§References 5, 22–25, 37, 41, 47, 53, 55, 58–65.

Figure 6. Climber on an artificial climbing wall in the frog position: knee hyperflexed and the whole leg turned outward.

in about 10% of elite climbers. Numbness, tingling, prickling, or itching sensations in the sensory distribution of the median nerve (volar side of index finger to radial side of ring finger and adjacent skin areas of the hand, dorsal side of distal index and long fingers, particularly at night, are typical for this disorder. MRI in 3 climbers with carpal tunnel syndrome disclosed thickened cross-sectional areas of the muscle bellies and tendon sheaths of the flexor digitorum profundus and superficialis at the carpal tunnel. Conservative management with reduction of the training load, nonsteroidal anti-inflammatory agents, and physical therapy, as well as surgical decompression for severe cases, is described.

Additionally, classic overuse syndromes with acute or chronic peritendonitis or tendonitis and wrist sprains can occur separately. Rest and rehabilitation with nonsteroidal anti-inflammatory medication, and, if necessary, splinting for 2 to 3 weeks, is usually sufficient to relieve symptoms.[¶]

Elbow

Four soft tissue injuries of the elbow (Figure 5) caused by slow regeneration of tendon tissue after repeated mi-

crotrauma are recognized: classic medial and lateral epicondylitis, anterior elbow pain (climber's elbow), and triceps tendonitis. Very high stress in climbing leads to insertion tendonitis from such microtrauma. The superficial finger flexors, the wrist flexors, and the pronator teres muscle all insert at the medial epicondyle of the elbow. If those muscles, which perform most of the grasping and holding of climbing, are overused and are not allowed to regenerate adequately, medial epicondylitis develops. Lateral epicondylitis develops as an overuse syndrome of the wrist and finger extensors and the supinator muscle, which insert on the lateral epicondyle. Overuse of the less well-trained extensor muscles in climbing results because optimal power of the flexors is obtained only when the wrist is extended.

Anterior elbow pain, or climber's elbow, was first misdiagnosed as biceps tendonitis but actually is tendonitis of the brachialis muscle. It is caused by overuse of this muscle in a position where the biceps muscle is not or is only insufficiently functioning, which occurs with flexion and pronation of the elbow, particularly during long traverses on climbing walls.

Triceps tendonitis occurs after mantle-shelf movements, during which arms flexed at the elbow and pushing downward initially support the body's weight. Inju-

[¶]References 25, 26, 31, 33, 37, 43, 51, 55, 66.

ries occur when the arms and elbows are extended to push the body higher.

In some individuals, antecubital fossa pain is not an indication of a lesion of the brachialis or biceps brachii muscles, but of compression of the posterior interosseous nerve (a branch of the radial nerve) between the 2 lamina of the supinator muscle, which can be inflamed and swollen by excessive climbing.

Simple conservative therapy such as icing, nonsteroidal anti-inflammatory medication, physical therapy, and relative or absolute rest followed by a gradual return to climbing should be sufficient for most elbow problems. For severe injuries, immobilization of the elbow joint with a splint or a cast may be needed for a short time. Surgical intervention for nerve compression syndrome has been described.

The strength of both flexor and extensor (agonist and antagonist) muscles must be checked to ensure balance. Climbers must be encouraged to include training and stretching of all forearm muscles in their daily exercise program.^{||}

Shoulder

Shoulder problems in sport climbers are quite common because most climbing is done with the arms above the head. Pain can be caused by impingement as well as by biceps tendonitis. Primary and secondary impingement must be distinguished. In primary impingement, imbalance and injury of the rotator cuff caused by training errors leads to the classic picture of a painful arc and positive Hawkins and abduction tests. Therapy is usually conservative. Operative therapy is reserved for severe impingement syndromes, but anterior acromioplasty has been performed for climbers with chronic, persistent pain.

Secondary impingement can result from disorders such as a SLAP lesion (superior labrum lesion from anterior to posterior) with superior instability. Arm positions above the head can lead to maximal shear and pull forces on the biceps tendon. The clinical picture of a SLAP lesion is very variable. Typical features are pain in forced internal rotation from an abduction-external rotation position, snapping in movements above the head (Crank test), and a positive O'Brien test (pain occurring with forced flexion of the extended arm against resistance in pronation of the forearm in contrast to supination of the forearm). An MRI with an intra-articular contrast agent can confirm the diagnosis, and operative therapy such as arthroscopic repair can be undertaken.

Isolated damage to the tendon of the long head of the

biceps muscle in the shoulder joint region can occur and is often associated with the use of training apparatus, primarily hangboards.

Shoulder dislocations seem to be rare and are seldom mentioned. Nevertheless, they were present in 4% of injuries to top climbers. A reduction with one of the classic methods is the treatment of choice, followed by a period of rest and intense physiotherapy with specific muscle training after identification of the reason for injury.^{7,11,24,37,67-77}

LOWER EXTREMITY

Because the upper limb takes most of the punishment in modern sport climbing, injuries of the lower limb are less common. Nevertheless, some soft tissue injuries are mentioned in the literature, and a specific entity involves the knee joint. Although in earlier literature about sport climbing, specific foot problems were only occasionally mentioned, newer publications describe a high rate of footwear-related problems, with deformities as well as soft tissue and neurological complaints.^{24,39,42,52}

Knee

The most prominent accidents are meniscal tears. They occur mostly when a climber is moving up from a position in which the knee is hyperflexed and the whole leg is turned outward—the frog position (Figure 6). Injury occurs when the meniscus is put under load and rotational stress. Sudden pain can be accompanied by locking of the knee, swelling, effusion, and inability to walk or bear weight on the injured extremity. Clinically, the appropriate tests for meniscal injuries (Steinmann I and II, hyperflexion and hyperextension, McMurray, Apley, Payr) may be positive, and tenderness is present above the joint space. An MRI can be diagnostic. For meniscal tears, conservative treatment is usually unsuccessful and arthroscopic therapy is required. In certain circumstances, meniscal tears can be repaired, but usually part of the meniscus has to be resected. The appropriate rehabilitation program depends on the surgical technique used.^{**}

Foot

Sport climbers often buy climbing shoes several sizes smaller than street shoes (Figure 7). The smaller shoe holds the foot in a supinated, stable position while the thinness of the shoe increases proprioceptive sensitivity. Climbing shoes are supposed to fit like a second skin. To obtain this fit, nearly 90% of climbers accept pain

^{||}References 5, 8, 19, 24, 25, 31, 32, 35-37, 48, 51.

^{**}References 31, 51, 67, 68, 71, 74, 75, 77-79.

Figure 7. The author's running shoes vs his climbing shoes (slipper type for indoor use). The climbing shoes are several sizes smaller than the running shoes. Outdoor climbing shoes often have a shoelace system to enhance the tightness of the shoe.

during and after climbing. The small shoes also induce specific foot deformities as well as musculoskeletal, neurologic, and dermatologic problems.

Hallux valgus, defined as a 20° difference between the axis of the first metatarsal and the axis of the proximal phalanx of the toe, was noted unilaterally in 53% and bilaterally in 20% of climbers participating in the sport for more than 5 years and climbing UIAA degree IX.⁵²

Soft tissue complaints include high pressure points at the interphalangeal joints of the hallux and lesser toes, the dorsum of the foot, and over the insertion of the Achilles tendon. Toenail pain and soreness, as well as subungual hematomas, dystrophic nails, and toenail infections are often present. Medial to lateral compression of the forefoot is applied by the small shoes and possibly is responsible for the pressure on deeper nerves, vessels, and soft tissue structures that results in tingling and numbness in up to 65% of sport climbers.^{5,39,42,52}

Therapy guidelines for these foot problems have yet to be defined. After accepting shoe-size reduction as a necessary evil in sport climbing to maximize climbing performance, recommendations include optimal preclimbing and postclimbing hygiene of the feet, parallel training or rehabilitation programs that strengthen and stretch all muscles of the foot, and appropriate-sized street or sports shoes that do not compress the feet when the person is not climbing.

Ankle sprains in bouldering and sport climbing are reported in up to 24% of climbers. In bouldering, climbers ascend unroped to a height of 10 to 15 feet, and if they fall, they usually land on their feet, which absorb much of the impact. As the foot is already in a forced supinated position because of the small climbing shoe, the likelihood of ankle sprains is increased. Thick mats that provide adequate energy absorption and cover an entire potential landing area have resulted in a lower injury rate.

The origin of ankle sprains in sport climbing is different. This injury can occur when climbers fall into the rope in overhanging walls. A falling roped climber on vertical walls swings into the face, usually extending the legs to brace the body for impact. Both dorsiflexion and plantar flexion-inversion sprains may occur. Therapy for ankle sprains follows the routine guidelines established for ankle injuries in orthopedic surgery and sports medicine.^{4,39,52,53,67,68,72}

Miscellaneous

Various muscle injuries, including acute adductor sprains and quadriceps or hamstring strains, have been reported. Therapy follows the guidelines for muscle sprains or strains. Thorough physiotherapy and slow restart of climbing activity are necessary. For individuals with such injuries, a detailed warm-up and extensive stretching exercises are recommended before and after the climbing activity.^{7,11,25,67,68,74,75}

BACK AND ABDOMEN

As with the lower extremities, sprains and strains have been extensively reported. Additionally, specific overuse syndromes of the cervical spine as well as of the lumbar spine have been described. The cervical spine is often hyperextended while belaying a partner up vertical or overhanging rock faces, resulting in typical muscle pains and disorders such as arthritis of the facets of the cervical vertebra. A higher incidence of damaged lumbar intervertebral disks is also reported in climbers. Possible causes include functional problems such as shortening of the pectoralis muscle, resulting in kyphosis of the thoracic spine and lordosis of the lumbar spine, and frequent falls when held by

Figure 8. A roped-up climber leaving the overhanging part of the artificial climbing wall to start the horizontal traverse on the ceiling (route leading from top right to the bottom left of the picture, 2 couples of spotlights being on the left side of the picture).

a rope. Treatment follows classic guidelines and includes physical therapy with stabilizing exercises for the back and abdomen and strengthening of the muscles.^{5,31,58,80,81}

FRACTURES

Although fractures are common injuries in classic mountaineering and traditional rock climbing, the incidence in sport climbing is quite low. Accidents producing multiple traumatic injuries are exceptional. Nevertheless, if a fall is not adequately controlled, and appropriate safety gear such as a helmet is not worn, fractures of the skull or other bones can occur. Bones of the forearm (distal radius) and the hand (scaphoid) may be fractured when a climber reflexively tries to stop his body from colliding with a rock face or climbing wall. Ankle fractures have been reported as common on climbing walls, but matting with adequate energy-absorbing qualities may reduce their incidence. Treatment for such fractures follows the usual guidelines, although special emphasis must be given to step-by-step rehabilitation of the climber.^{4,24,26,67,68,75,82}

Repetitive compression and tensile stress on fingers in finger jams, finger locks, hand jams, fist jams, and grip handholds place climbers at risk for stress fractures of the

bones of the hand. Any injury thought to result from overuse of muscles and tendons that is not responding to treatment may be a stress fracture and may require alternative treatment. In 1 case report, physical examination revealed point tenderness over the involved phalanx, painless full range of motion, and periosteal changes over the ulnar aspect of the phalanx in routine radiographs. A stress fracture of the proximal phalanx of the right index finger was diagnosed and treated by “buddy taping” the index finger to the middle finger for 6 weeks. Pain resolved within 1 week, and the individual was able to climb 9 weeks later.⁸³

Conclusions

When treating sport climbers, physicians must know the overuse syndromes and injuries typical of this relatively new and fast-growing mountaineering/climbing entity. Furthermore, a physician must have enough patience with and sympathy for “this group of hopeless adrenaline addicts”²⁴ (Figure 8) to take time to explain the details of the overuse syndrome or injury and the rehabilitation program and caution the climber against early resumption of climbing that could lead to severe chronic problems with the injured structures. Additional studies are needed to elucidate the

evolution of degenerative changes in sport climbing to be able to offer optimal prevention schemes. Prevention in the form of extensive warm-up and stretching sessions, and professionally guided gradual training schemes that allow longer rest periods, cannot be overemphasized.

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