ONE MOVE TOO MANY...

HOW TO UNDERSTAND THE INJURIES AND OVERUSE SYNDROMS OF ROCK CLIMBING

Thomas Hochholzer
Volker Schoeffl

Editor: Sam Lightner Jr.

Dr. med. Thomas Hochholzer was born 1958 in Altötting, Germany. He is specialist in orthopedic surgery and sports medicine. He completed his thesis on high altitude physiology. Since 1997 he runs his own clinic in Innsbruck, Austria.

Thomas has climbed since 1978 and was a member of several expeditions to Alaska, India, Tibet and New Guinea. He conducted many scientific studies on climbing injuries and is the author of *Trekking und Höhenbergsteigen* (trecking and mountain medicine).

Dr.Volker Schoeffl was born 1965, in Schweinfurt, Germany. He received his degree in medicine at Wuerzburg University and is now a specialist in surgery, trauma-surgery, and sports-medicine. He is the team physician of the German Sport-climbing National Team and a Member of the Medical Commission of the UIAA.

Volker has climbed for over 20 years and has done many first ascents up to the grade of 8b (5.13d). He has been a member of various climbing expeditions to countries such as Nepal, Borneo, Burma, Laos, etc.

He has a passion for understanding climbing injuries, of which he has published many papers and regularly gives lectures on the subject. Besides his scientific approach to medicine as it relates to climbing, Volker has worked as a climber on movies, written books, regularly gives slide shows, and aids in the development of climbing gear (Roc'tera shoes, Flash liquid chalk, etc.).

It has been said that you should write what you know and for **Sam Lightner, Jr.**, with over twenty years of climbing 5.12 and at least 10,000 pitches, some days it feels like he knows too much. Sam has experienced tendonitis in his toes, ankles, shoulders, elbows, and fingers, and suffered from so many strains, ruptures, ganglions, and bone spurs that he is on a first name basis with surgeons, acupuncturists, and chiropractors around the globe.
It is this unique perspective that allows him to share advice, encouragement, and a dose of his trademark humor for the mysterious symptoms and disturbing popping noises suffered by climbers everywhere.

Sam is the author of *All Elevations Unknown: An Adventure in the Heart of Borneo* and *Exotic Rock: The Travel Guide for Rock Climbers*. He has survived tropical diseases and dodged poisonous snakes, bullets, and terrorists in some of the Earth's most dangerous places. Sam has appeared on television and radio as well as in the pages of National Geographic Climbing, Rock and Ice, and many other publications worldwide.
His stories, lectures, and slide shows have fixed him in the hearts and minds of his peers, his fans, and armchair travelers alike.

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with contribution of
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approved by the Medical Commission of the UIAA

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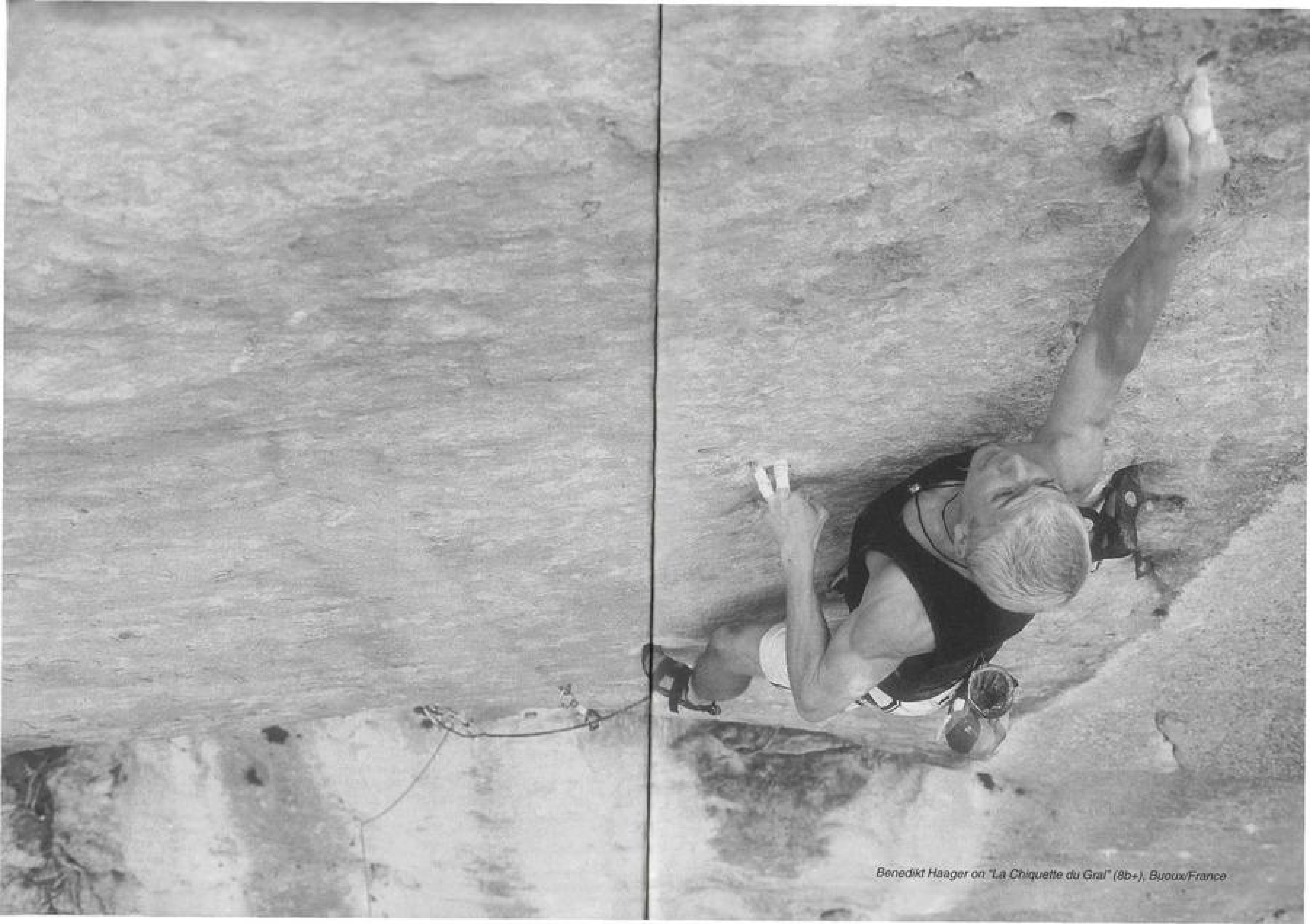

Benedikt Haager on "La Chiquette du Gral" (8b+), Buoux/France

One Move too Many...

Free climbing has always been the most common approach to climbing mountains, but the distinction between it and "aid" was not seen as relevant to most climber's sense of style until recently. For most of the sports history the summit has been the goal, with the route and style taken to reach the summit mostly of secondary value. Climbing was simply climbing, and the means of ascent, with a few exceptions, was not worthy of questioning.

There is one area, the Elbsandstein in modern eastern Germany, where the modern style-oriented free-climbing approach to climbing has been used for over 100 years. In the Elbsandstein the use of pitons and bolts for upward ascent was seen as cheating, so only a climbers hands and feet could be used to scale a face. In 1918 Emanuel Strubich free climbed the "West Arete" at the Wilde Kopf, creating the first free climb to be graded UIAA 7–, or 5.10. It was a monumental achievement that other free climbers, like Berndt Arnold, would build on in the future. However, with the beginning of the Cold War the East German climbing scene was lost on the rest of the world and the concept of trying to "free" a climb went with it.

For the rest of the world, the sports of rock climbing and mountaineering went through a radical transformation in the late Sixties and early Seventies. The hippie generation of climbers in Yosemite Valley began looking at the route, rather than the summit, as the most important part of the climb. With that, the style of climbing was brought into question, and the quest for ascending a route specifically by "free climbing" was born. The rope, pitons, and new pieces of clean-climbing protection called nuts, were soon being used to arrest a fall rather than aid the ascent. The grades of difficulty in free climbing soon began to jump off the scale.

Two Americans, both climbing in relative obscurity to the popular climbing scene in Yosemite, perhaps made some of the biggest jumps seen yet in free climbing. John Gill brought gymnastic skills, and many of gymnastics training techniques, to the sport in the early 60's. Using the before unseen gymnast chalk to keep his hands free of sweat, Gill established boulder problems that would not be seconded for a decade or more. One, "The Thimble", would be a four or five bolt sport route today and was undoubtedly the first UIAA 8, or 5.11+. Following him was Tony Yaniro who approached the sport with training techniques he'd learned from the U.S. Olympic Team. Yaniro took a systematic approach to training and used specially designed equipment, like an early version of the campus board, to improve his skills as a free climber. All of this training paid off for him in 1979 with the first ascent of "The Grand Illusion", the world's first 5.13c (UIAA 10–). Jerry Moffat of the U.K. added the next route of the grade, "The Face", in 1983, and then the phenomenal Wolfgang Guellich of Germany began to push the grades even higher. He established "Wallstreet" (5.14b, UIAA 11–) in 1987 and then "Action Direct" (5.14d, UIAA 11) in 1993, a route that would hold off a second ascent for years to come and to this day has only seen a handful of successful attempts. Most recently, Chris Sharma's "Realization", conservatively graded 5.15a, has raised the bar a bit more, while boulderer Fredrick Nicole has established a number of V14 and V15 (fb 8b – 8c) boulder problems.

As the grades in difficulty increased, the will of climbers to compete with one another increased as well. Speed climbing competitions existed in the Soviet Union for many years, but competitions in difficulty really first came to be in the 1980's. Artificial walls were constructed to hold the competitions, which evolved into World Cups and European Championships in the early 1990's. Training for climbing became a must, and climbing gyms with artificial walls sprang up all over the world, many having their own local competitions.

Seeing the grades in difficulty shoot upward, its hard to imagine the world just 20 years ago when modern "sport climbing" was barely an accepted form of the sport. However, only over the last two decades have we been pushing this hard, which means sports medicine has only recently seen such injuries as pulley ruptures or compartment syndrome in the forearms. The first time climbers fingers were surveyed was in 1989, thus the solid base to begin studying hand injuries and improve diagnosis and treatment is only 14 years old. Recently, the number of doctors internationally who are interested in this field and are working with climbers has begun to increase. In 1998 a conference was held in Salzburg, Austria, specifically for doctors to discuss sport-climbing injuries.

This book is meant to bring to you, the climber, some knowledge of how those changes to climbing have affected us as athletes. It is also meant to help you understand physiologically what is going on in your body when you climb and train. The information you get here is a good base of knowledge for you to take to a doctor or physiotherapist when you think you are suffering from one of the injuries or syndromes. Also, as medicine for climbers is still in its infancy (relative to other sports like skiing or football), many doctors might not realize what levels of stresses are being placed on your body. Your knowledge of what might be happening will help the doctor make an informed decision and point you down the correct road to recovery. That said, you should also know this:
This book is not here for you to make a self-diagnosis and then come up with your own treatment. Any problem you have that brings you to reading this book should be looked at by a trained professional as the exact diagnosis is very difficult to make. This book is to help you understand that diagnosis.

This is the first English version of the German book *Soweit die Hände Greifen*, which went into its 3rd printing in 2001. This version has been edited with more of an American/British slant. Besides the original authors, Dr.Thomas Hochholzer and Dr.Volker Schoeffl, Dr. Juergen Zapf helped with the chapter about nutrition and Dr. Guenther Straub with the chapter on anatomy.

Dr. Thomas Hochholzer, Innsbruck, 2003
Dr. Volker Schoeffl, Bamberg, 2003

Another note on the English version:

The translation was initially done by Dr. Volker Schoeffl with a bit of help from Birgid Donaldson. I, Sam Lightner Jr., edited the German version so as to make it a bit more English/American like. By that, I mean my job was to make sure commonly used terms were present and that the verbs and nouns fit together as we use them. This was done by re-editing sections and forwarding them to Volker for approval of the medical syntax. This done, he would fire it back for me to cross the 'T's and dot the 'i's. A few more times back and forth and we had this version. Because of the language gap and the different approaches German medical schools take relative to American medical schools, doctors from the U.S. might note some terms that are not the exact syntax of the American Medical Association. When in doubt we stuck with a common German term, which was Latin and therefore often close to the correct term for English speaking doctors anyway.

I got to work on this book not as a doctor but instead by being a writer and climber who has suffered through many of the injuries discussed here. I made an effort to use the terms like "Tennis Elbow" or "Funny Bone" as I knew many people would know the terms and not the Latin lateral epicondylitis or epycondyli osseous attachment. Other terms, like "pumped" or "crimp" are also not medical in nature, and perhaps not even accepted yet as English, but we climbers know what they mean.

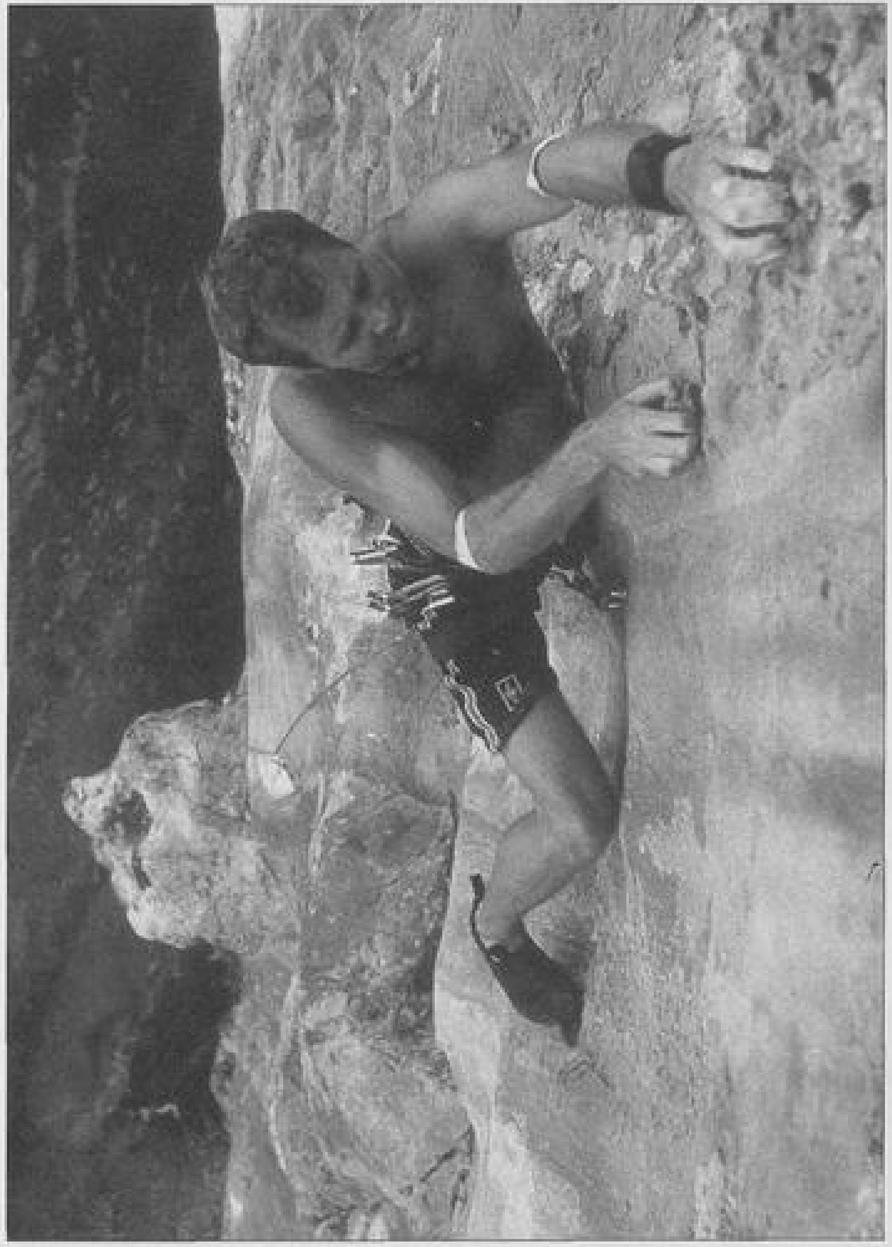
I would make a recommendation when you first begin to digest the anatomy section: watch yourself move the appendage you are reading about. I found I understood the mechanics of the hand, forearm, and elbow, as well as the mechanics of the injuries and syndromes that go with them when climbing, by watching them move from various angles.

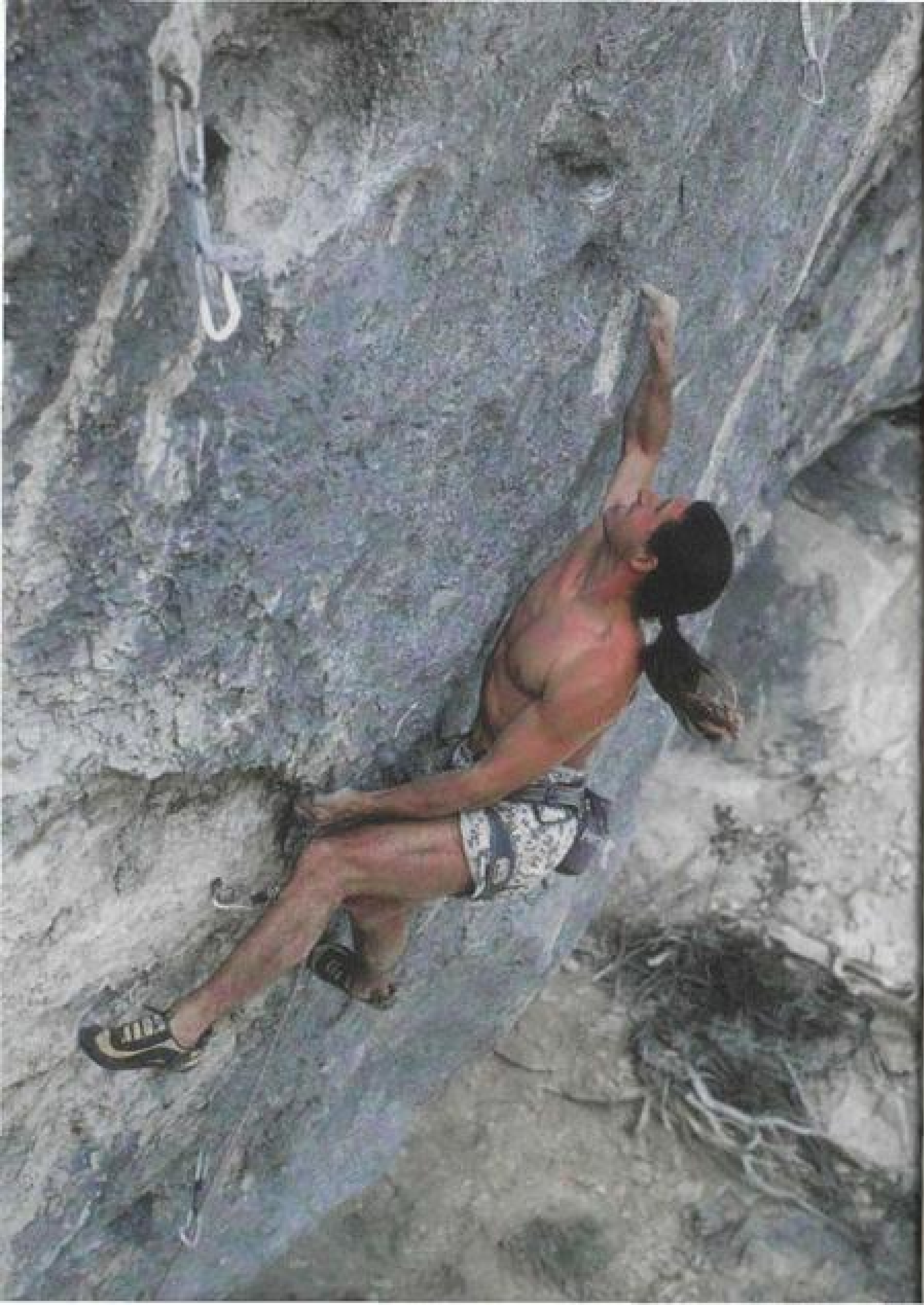
I would also reiterate a point made above with a revealing story. When I was helping Volker with the "Americanization" of this book, my close friend Kyle hurt his right hand while climbing. Knowing that I was working on this book, Kyle asked me what I thought had happened. I told him that according to this text it was probably an A2 pulley rupture, then told him I would ask Volker, via email, about it. Volker guessed it was the A2, but then had me pass on to Kyle that he should "Go see a doctor... it is important that a hands on exam is done by a physician." That says something. One of the most competent doctors in the world for this injury could not actually see the patient, so he told the patient to physically "see a doctor".

After reading the book and discussing the thought that went into its conception, I realize that any doctor looking at a possible injury or overuse syndrome understands what is going on in your body a thousand times better than you or I after having read this book. Do not use this book for self-diagnosis. Let the pro's figure out what is wrong. This book lays out what most doctors will look at to make a diagnosis and what they will proscribe to fix the problem. You can use this information to ask the doctor questions during his exam and to perhaps help him recognize the ways you are using your body when climbing. Any other use of this book is irresponsible and potentially dangerous.

Sam Lightner Jr., Railae Beach, Thailand, 2003

Sam Lightner on "Glass of Poison" (7b), Koh Taban/Thailand





1. Anatomical Basics

The hand and forearm form a functional unit and should not be looked at separately. With a few exceptions all the muscles that work the hand and fingers have their origins in the forearm. To understand the function of the hand and the fingers, as well as the injuries and overuse-syndromes that the hand and fingers suffer, it is necessary to understand the anatomy of the entire region.

The hands are essential for most of our sports, but not always for catching and gripping as we commonly think. The direct uses, like in basketball or tennis, are obvious, but more commonly the hands are used as stabilizers that provide equilibrium in sports like running, gymnastics, or soccer. In these sports the movements of the hands change the athletes balance and position and therefore help direct the movement impulses of the body.

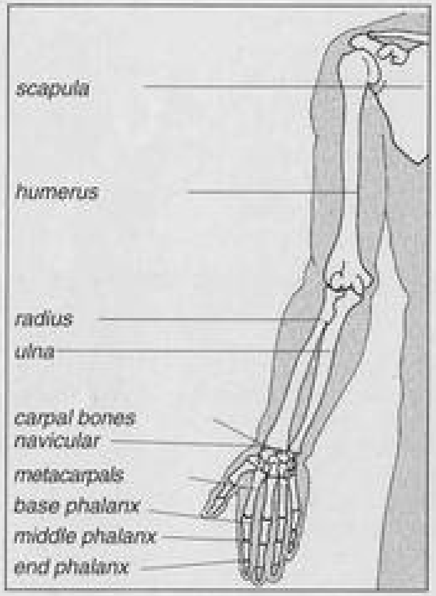
However, there is no sport where the forearms, hands, and fingers play as important a role and take as much abuse as they do in rock climbing. Climbers are the only athletes that focus their training on the enhancement of finger strength. The various methods used to gain the power and endurance required by modern rock climbers have created overuse syndromes and injuries that not long ago were unknown in sports medicine.

The ape's hand has adapted for climbing trees and vines.

The hand and forearm are made up of 29 independent bones, 38 muscles, and 3 major nerves, whose branches run out to every part of the appendage. The muscles form the active unit, but there are also many passive structures like tendons, ligaments, joint capsules, and pulleys. All of these components work with the

◁ Alexander Huber on "Hammerhai" (8c), Schleierwasserfälle, Austria

brain, as a unit, performing tasks and reacting within fractions of a second.



Anterior aspect of the skeletal arm: The ability of the radius to rotate against the ulna is essential for the rotation of the forearm.

When comparing the ape's hand to a human hand, the human hand is far more sophisticated and is able to do more complicated movements and functions. The main difference between our hands and those of our simian cousins is that the human hand's thumb is capable of touching the tips of all the fingers. This "opposition", as it is known in medical terminology, is required for common accurate movements that we often take for granted, as in writing, playing musical instruments, or even crimping and edge.

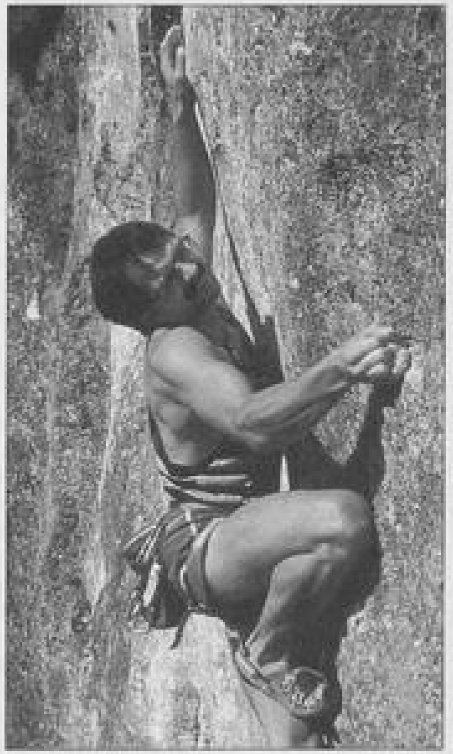
1.1 Bones, Joints, and Ligaments of the Hand and Forearm

The human arm is built like a tree, branching out more and becoming more complex as you get closer to the tips. The biggest and strongest bone of the arm, the humerus, connects the arm to the main body at the shoulder joint. Two bones, the radius and ulna, form the skeleton of the forearm and can be manipulated to work against one another. The twisting of the forearm, the act of facing ones palm up (supination) or facing ones palm down (pronation), is done by rotating the radius around the ulna. The ulna itself forms a hinge joint (like a hinge in a door) with the humerus, at the elbow, and therefore cannot rotate. Running between the radius and ulna is a tendon-like membrane (*Membrana interossea*) that divides the various forces and pressures between the two bones. For example, when doing push-ups the radius bears 80% of the load while the ulna bears the other 20%.

The wrist (carpus) is the connection between the radius and ulna and the bones of the hand. The wrist is an egg-formed joint that allows extension and flexion and side flexions to the side of the thumb (radial) and the side of the fingers (ulnar). The wrist joint does not rotate, so all of the rotational movements of the hand are a function of the forearm.

The eight wrist bones (carpals) are located in two rows of four bones that form two parallel arches. Many short and tight ligaments connect these carpal bones. The apex of these arches is on the dorsal, or palm side, and together with a very strong ligament called the Retinaculum flexorum, forms a tunnel. Running inside this carpal tunnel are the nine flexor tendons of the fingers and the medianus nerve. Though all eight carpal bones have multiple joint facettes with their neighbors, they have a limited amount of movement. The flexion and extension of the hand is done in the wrist joint and not in the small joints between the carpal bones.

The small lateral movements of the finger base joints allow us to place fingers above each other on a hold. (Hans-Dieter Brunner on "Mr. Olympia" (9–), Altmühltal/Germany)



The five middle hand bones, known as the metacarpals, form the main part of the hand (i.e. the palm and back of the hand). These bones are attached to the second row of carpal bones in the wrist via extremely tight ligaments. Starting with the index finger metacarpal, which has the limited range of between 2 – 3 degrees of mobility, the range of motion increases in each joint down to the little finger, which has a range of motion of 15 – 30 degrees. This range of motion allows the hand to form a bowl that can be used for holding large round objects, like a ball, or making a cup to gather water.

The base finger joints form the connections between the middle hand bones and the thumb and four fingers. The index finger, middle, ring, and small finger (pinky), are all made up of three different bones. These bones, medically known as phalanxes, are the base phalanx, the middle phalanx, and the end phalanx. The base finger joint, in addition to allowing flexion and extension movement, also allows small lateral movements from side to side through the flexing of small muscles in the hand. As an example, this motion is used in climbing when crimping and pocket climbing. By pulling our fingers from side to side we

Finger rotation helps to suit the finger position according to the various demands in climbing. (Radek Capek on "Bullet the Blue Sky" (5.12d), Penitente Canyon/USA)

can stack each digit together on a small edge or pull them all into a more round configuration so as to "bird-beak" three digits into a round two finger pocket. The third type of movement, rotation, is performed in a very limited scale in the fingers, and is only done when "cupping" as mentioned in the above paragraph.

The thumb is actually quite different from the long-fingers. For starters, it lacks the middle digit, having only a proximal and a distal phalanx. Having one joint fewer than the other digits, the thumb is much shorter. However, the joint where the thumb meets the hand, the carpometacarpal joint, commonly known as the "Saddle Joint", has a far greater range of motion than the equivalent joints in the four fingers. In conjunction with the small muscles in the hand, the Saddle Joint allows the thumb to work in "opposition" of the other fingers. This "opposition" is essential for much of how we utilize our hands, as when using a pen, opening a door, or using eating utensils

The middle and end finger joints, known as the proximal interphalangeal joint (P.I.P) and the distal interphalangeal joint (D.I.P), only allow motion in the flexion and extension directions. Over extension, as well as over shifting to the sides, something important in finger crack climbing, are prevented by a very tight volar (palmar) joint capsule and by collateral ligaments on the sides of each finger.

The joint capsule that encloses the joint has two basic functions. It serves as a stabilizer that protects the joint against outside forces that would over stress the joint in any direction. Also, the joint capsule produces a fluid known as synovia that helps move nutrients into the cartilage and keep the joint lubricated. This process, known as diffusion, takes place through the motion of the joint. The more motion, the more fluid is created, and more diffusion takes place. However, overuse of the fingers can produce an excess of synovia, which then stretches the joint capsule, which is then transferred to the brain via nerve endings as pain. Obviously there is a need for equilibrium in synovia. Since healthy cartilage lacks blood vessels, synovia is important in maintaining the cartilage surface, but too much can cause problems.

NOTE

Each joint is made up of the same components: The bone with a layer of cartilage, a joint capsule and ligaments that hold the joint together along with muscles and tendons that manipulate the joint.

1.2 Muscles

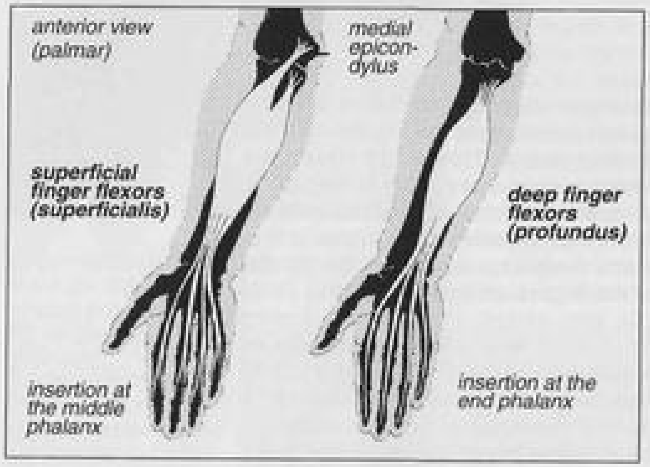
The finger power necessary for climbing is achieved by using both the passive components, the bones and ligaments, and the active components, the muscles. Though the fingers are powerful they contain very few muscles. The flexing parts one feels move in the fingers are almost all tendons carrying the dynamic movement from the muscles to the bones and ligaments. The biggest and most important muscles for the flexion and extension of the fingers are in the forearm.

NOTE

The forearm muscles need to be divided into two main groups: the flexors and extensors. The extensors of the thumb form their own unit. The flexors are located on the palmar side of the forearm while the extensors are located on the dorsal side.

The muscles that exist in the forearm are responsible for both the high range of motion of the hands and fingers as well as for those motions that require a lot of power. These muscles span much of the arm, with some originating as far away as in the upper arm and relaying their power all the way down through the elbow, wrist, and finger joints to the fingertips. The lower part of the forearm, where the arm is harder and thinner, is mostly made up of tendons and bone. The tendons for the flexor muscles form roughly in the middle of the arm and lead down into the fingers. When flexing the wrist joint on the palmar side some of the tendons can be identified independently. Add some movement to the fingers and one can see the forearms relaying the movement of the finger through these long tendons. All put together, there are 38 muscles in the forearm contributing to the control of the hand and fingers

The names of all of these muscles are mostly related to their function or origin and, like so many other parts of the human body, are Greek or Latin words. The Latin name has an M. (musculus) for muscle and then a description of its function. If we are talking about a group of muscles connected to each other or working in the same way, the plural Latin word for muscles, musculi, is applied and is represented through Mm. As an example, the extensor muscles of the forearm would be called Mm. extensorum digitorum.



The origin of the extensor and flexor muscle is partly also at the humerus.

Next to the flexor and extensor muscles there are muscles that are responsible for the internal or external rotation of the forearm. The rotation of the forearm to the outside is called supination. You can remember this by imagining the position your hand would be in to carry a bowl of soup (soup – supination). The rotation to the inside is called pronation. The muscles that control supination lie in the extensor group while the muscles for pronation are inside or underneath the flexor muscle group. Supination and pronation are important motions for climbing. Imagine yourself doing a thumbs down jam in a crack without the ability to twist the hand in supination. The biceps muscles, as well as the musculus supinator, are also used in outside rotation/supination.

NOTE

Two muscles are mainly responsible for the flexing of the finger: the deep and the superficial finger flexor (*M. flexor digitorum profundus; M. flexor digitorum superficialis*)

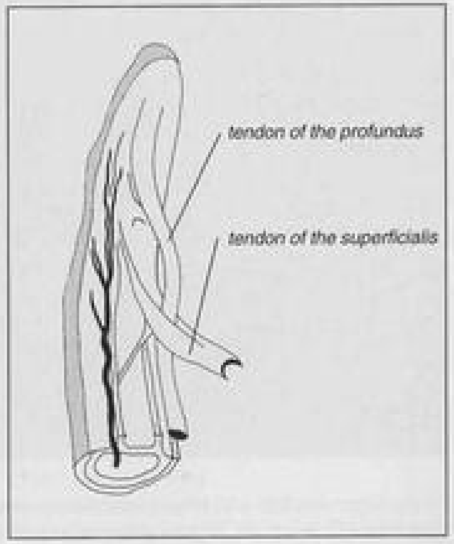
The origin of the flexor and extensor muscles is partly in the forearm on the radius and ulna and partly in the upper arm on the medial and lateral side of the humerus. The muscle

origins on the upper arm that can easily be found are called the epicondylus medialis and epicondylus lateralis. The epicondyli are osseous attachments that grow away from the bone to increase the mechanical advantage of the muscles. We often refer to it as the "Funny Bone" because of the pain one gets when the nerve running next to it is accidentally hit (personally, I never find this pain "funny").

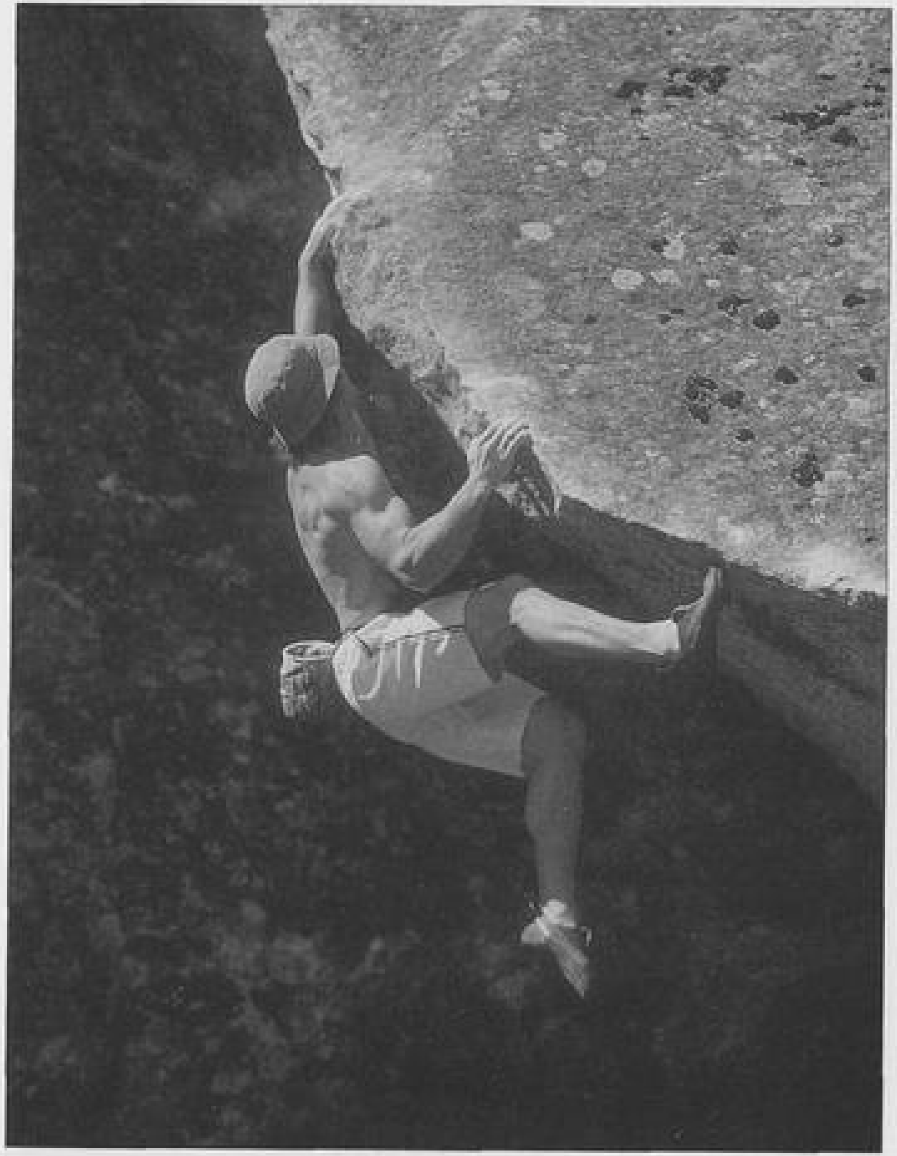
In the legs, the extensor group is stronger than the flexor group because it has to push against gravity when walking and standing (as in extension of the knee joint). The opposite is the case in the forearms. Here, the main working muscles are the flexors and they are therefore larger and stronger. The flexors are at work when making a fist or doing any kind of gripping, whether it be a fork or a climbing hold. The extensor muscles are mainly used to counteract the motions of the flexors, as in the opening of the hand from a hold or releasing a fist. Both groups, the flexors and extensors, are responsible for moving the wrist joint up and down.

The superficial finger flexors have their origins in two different spots in the arm. On the humerus, the upper arm, they attach at the epicondylus medialis, a point just above the elbow. The remainder of the attachments are on the ulna and radius of the lower arm just below the elbow. This spread in the attachment means that when your arm is bent at the elbow and your fingers are flexing, as they often are when climbing, the superficialis is under a lot of tension. This is one of the reasons these tendons see such a high frequency of overuse syndromes in climbers.

The tendon of the profundus muscle pokes through the superficialis tendon



The deeper flexors (*Mm. flexor digitorum profundii*) have their origin in the bones of the lower arm, the ulna and radius. Their origin is combined as one thick tendonous muscle that spreads into smaller muscles and tendons as it works its way down the arm to the fingers. Each finger has one superficial and one deep flexor muscle for its operation. Since those muscles are separate units, each finger actually has two flexor tendons.



Slopy finger position and an extended wrist joint allow a low stress and perfect power transfer. (Gerhard Hörhager on "Hotel California" (Fb 7b), Zillertal/Austria)

The tendon of the superficial flexor forks in the finger and attaches at two points on the middle phalanx. The tendon of the deep flexor (profundus) runs through the attachments of the superficial flexor and attaches in the distal phalanx (your last digit). This division of the superficialis and profundus makes it possible to separately move the middle and last digit of the finger.

The superficial flexor muscle works multiple joints so it is under a great deal of stress. Also, it suffers from a condition known as "functional insufficiency", meaning it is weaker in some positions than it is in others. For example, if you flex your wrist as hard as you can so that the palm is brought close to the forearm, you will find it difficult, if not impossible, to make a fist or do any action requiring intense finger power. However, the muscle gives its highest degree of finger power when the wrist is in the opposite position, known here as over-extended. By simply putting your hand in the over-extended position, that is flexing the extensors and pulling the wrist back, you can see the fingers naturally want to form a hook. This position creates a pre-tension of the finger flexors and allows the extensors to apply some force into the hand. This is one reason why we generally do our "crimping" of small holds, where we need the most power, in this position.

We commonly think of our finger power coming from the flexors as that is where we feel the "pump" when we are tired, but we should remember that the extensors are also brought into use when maximum power is called for. As the extensors weaken, the wrist goes into a more neutral position requiring even more force from the flexors. At this point your elbows will naturally begin to move back from the wall so as to force your hand into an even more flexed position you (commonly referred to as "chicken wings"). Eventually, this method of finding the most powerful position doesn't work either and the hand lets go.

Knowing how the complex system of the forearm and hand works is very important for climbers. Knowing, for instance, that pulling back the wrist (seven or eight centimeters on average) adds tension to the fingers reminds us we need to train our extensors as well as our flexors. It also explains, especially when one thinks of the angles involved at the elbow when it's flexing and the "chicken wing" effect begins, why climbers so often suffer from tennis elbow (insertion point tendonitis of the extensor muscles at the lateral epicondylus).

For those who want to understand more thoroughly how their fingers work, the small muscles of the hand are very interesting. These muscles have a precise influence on the coordination of finger movement, and because they are so complex their movement is a bit difficult to explain... so bear with us.

The middle hand bones serve as the origin of the short, or intrinsic, hand muscles, while another group, the extrinsic, have their origins in the forearm.

There are a number of intrinsic hand muscle groups:

1) The thumb muscles, both the long flexor and long extensor

2) The small finger muscles, which work analogous to the muscles of the thumb

3) The interosseous muscles (*Mm. interossei*), which originate on the sides of the middle hand bones (metacarpal). The interossei muscles and tendons take up most of the space between the carpals. They run in two different layers, running from more or less the palmar side of the hand and ending on the dorsal (extensor) side of the fingers. These muscles are responsible for spreading and rotating the fingers, but they have another job that is very important to climbers. The *Mm. interossei* flex the base finger joint (metacarpophalangeal joint) and extend the interphalangeal joints. These muscles give us the ability to fully close a fist, but they also give climbers the ability to hold onto big sloping holds where the entire hand is gripping. For this reason, climbers tend to have visibly thicker hands than the average person, and MRI (Magnetic Resonance Imaging) exams have shown that these muscles in climbers are twice as big as they are in the general public.

4) The lumbricales muscles (*Mm. lumbricales*), take their name from the Latin word for worm, lumbricus, as they very much resemble worms inside the hand. They have a mobile origin at the deep flexor tendon ("mobile" as the flexor tendon moves itself) and run parallel to the interosseus muscles to the base finger joint. Their insertion point in the fingers is at the same insertion as the extensor tendons. These muscles coordinate the functions of the finger tendons between each other and also serve in a similar manner to the *Mm. interossei.*

The movement of the fingers is a complex and highly coordinated act using many different muscles and tendons. To flex a straightened finger, the very simplest of motions, the intrinsic muscles must begin by flexing the base joint slightly. After this initial action of the intrinsic muscles, the superficial and profundus flexors can begin working simultaneously to complete the movement.

In the functional unit the "muscle-tendon", the weakest points are in the tendon and the tendonous origin of the unit (where it erases from the bone). When activated, the muscles get a very high level of blood flow, while the tendon receives very little blood flow. Also, as a muscle grows through training, either by endurance or power training, the number of small blood vessels delivering nutrients to the muscle actually increases in the muscle body. This is known as hypertrophy. The tendons and ligaments do not grow at the same rate and do not have the same level of vascular flow, so they do not get the same level of nutrients. The result can mean a stronger muscle relative to the tendon.

Another problematic area is the insertion point of the tendon to the bone. Because different materials are being attached together, and as the stresses created by the muscles are focused into a much smaller point, these areas tend to suffer more injuries than the rest of the system. A tighter and less limber muscle will add to the potential for overuse syndromes.

Flexion of the distal interphalangeal joint is performed by the deep flexor tendon (*M. flexor digitorum profundus*)

Flexion of the proximal interphalangeal joint is performed by the superficial flexor tendon (*M. flexor digitorum superficialis*)

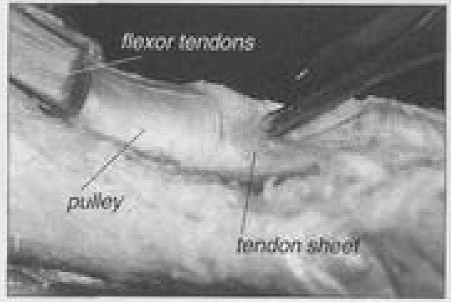
Flexion of the base finger joint is performed by the intrinsic muscles (*M. interossei*)

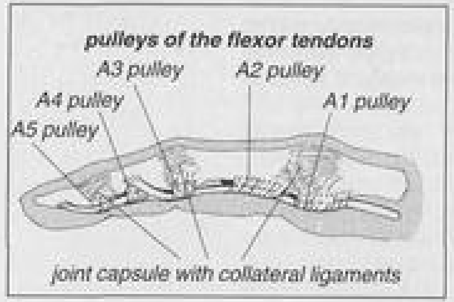
NOTE

1.3 Tendon Sheaths and Pulleys

The tendon sheath is held by tweezers. To the left of the tweezers is the A2 pulley. Further left is the partially removed superficial flexor tendon.

Generally speaking, a muscle does not attach directly to the bone. The muscle is a collection of elastic-like contracting fibers composed of myosin and actin. As it gets closer to its attachment to the skeleton, this fibrous tissue condenses and becomes a tendon. Unlike the muscle, which easily stretches and gets plenty of blood flow, the tendon is stiff and bradytrophic, meaning it gets poor blood flow. For these reasons the tendon is far more susceptible to injury than the muscle.





Most of the nutrition of the tendons is done via small blood vessels in the tendon sheaths, but some of the nutrients are delivered via the liquid that is inside the tendon sheath. In some areas of the tendon there are no blood vessels so all of the nutrition is done via this liquid. The areas that get the worst nutrition tend to be the areas most likely to have overuse syndromes and degenerative injuries. Tears in the tendon sheath, as well as chronic inflammation of the tendon sheath (tendovaginitis), make the flow of nutrition even slower.

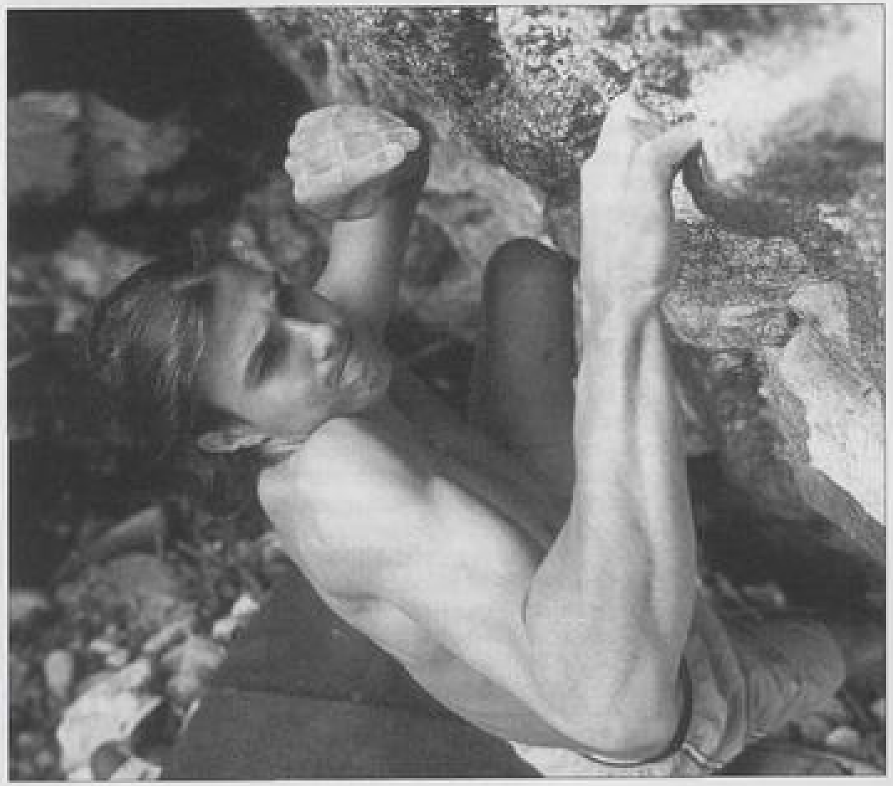
For climbers, the pulleys of the flexor tendons are very important.

The flexor tendons run through the fingers in tendon sheaths. These sheaths protect the tendon, give it nutrition as stated above, and lubricate it so as to reduce friction. In the fingers, the sheaths are fixed in position by five annular ligaments commonly called "pulleys". These pulleys can be thought of as the rings on a fishing pole, holding the line in place along the rod even when it flexes and bends. The first pulley is located at the main fold of the palm, while the others are located at the base phalanx, the middle phalanx/joint, and the end joint of the phalanx.

The pulleys are under tension in most finger positions. At the crimping position, where the fingers are on small edges with the overextension of the end joint (as described before), all of the pulleys are under high friction and tension.

In this highly stressed position, sudden movements can lead to a partial or complete rupture of a pulley. Also, overuse syndromes caused by a combination of many small injuries are common when repeatedly stressing the fingers in this position. The most commonly affected ligament is the circular A2-pulley at the base phalanx. (The "A" stands for the Latin "*Ligamentum annulare*" while the "2" refers to the fact that it is the second ligament starting at the palm and running down the finger). If a pulley is totally ruptured it leads to a shift, or dislocation, of the tendon out of its bed during any flexing. This is commonly referred to as "bowstring", as it has a similar appearance to the string that runs from tip to tip in a bow (a bow-and-arrow bow). A ruptured pulley changes the pivot of the tendon and as a result there is a loss of tension strength and power (not to mention a little pain!).

Markus Schwaiger bouldering at the Happy Place, Zillertal/Austria



1.4 Upper Arm, Shoulder and Trunk Muscles

Flexor and extensor muscles can also be found in the upper arm. The extensors are the triceps (*M. triceps brachii*), a muscle with three different bodies. The flexor group is formed by the well-known biceps muscle (*M. biceps brachii*) and a generally not so well known muscle called the brachialis (*M.brachialis*).

As its name suggests in Latin, the triceps is made up of three muscles that each have their origin in the upper arm and shoulder. The triceps is the only extensor muscle in the elbow joint. The two different muscle bodies of the biceps ("bi" being Latin for two) have their origins in the shoulder joint and scapula. The biceps is the strongest flexor and supinator (outside rotation) in the elbow joint. Its tendon inserts at the radius and, when flexed, rotates the arm around so that the lower arm flexors are facing up (as in a curl).

The *M. brachialis* originates in the frontal part of the humerus under the biceps, runs through the elbow joint, and connects with a tendon in the forearm at the ulna. The brachialis is used mostly for static work; it tends to be used for holding a position more than for moving the joint. This muscle is more active when the dorsal part of the hand faces upward or outward, as in the majority of face climbing moves. The bicep is utilized best when turning the palm up, as in under clinging. This muscle is most likely to be injured when in this position, while the pain you feel after lots of chin-ups is generally coming from the brachialis.

At the top of the shoulder and shaped like a triangle, or a "delta" in Latin, is the deltoid muscle (*M. deltoidus*). The deltoid is broken down into three different parts, which any one or combination there of, come into play when moving the shoulder joint. The deltoid, used in combination with the supraspinatus, is the most powerful elevating muscle of the arm. The deltoid covers the so-called rotator cuff in the shoulder joint. The rotator cuff inserts as tendons in the humerus and is frequently the origin of degenerative problems of the shoulder joint. The rotator cap, or rotator cuff, is made up of the *M. supraspinatus*, the *M. subscapularis*, and the *M. teres major*, all of which originate on the scapula. Their functions are the rotation of the humerus to the inside or outside, the centralizing of the humerus head in the socket of the scapula in the shoulder joint, and the abduction of the arm. In

the soft tissue area between these muscles and the acromion, the bony knob above the shoulder, are multiple bursae with the bursa subacromialis and the bursae subdeltoidea being most important. A bursa is a liquid filled buffer, or pad, that sits between two bones that are regularly put under pressure. In many overuse syndromes these bursae can become inflamed and tender.

Several trunk muscles, for instance the pectoralis major and minor, the latissimus dorsi, and the serratus anterior, all have various important functions in the shoulder. They help to:

1. Fix the scapula to the trunk so that the independent movement of the arm is possible. An example of this would be a pull-up.

2. Move the trunk while keeping the arms in a fixed position. An example would be swinging your body while hanging from a bar or, in climbing, turning the body while holding onto a hold.

3. Rotate the scapula to the trunk. This is essential for elevating the arm more than 90 degrees from the body (elbows higher than the shoulder).

The scapula is only attached to the trunk through one joint, that being the acromioscapular joint. This is where the acromion attaches to the clavicle, more commonly referred to as the collarbone.

The main movements of the scapula, shifting and turning, are coordinated through various muscles (including the *M. rhomboidei* which were not mentioned above). Subtle movements of the scapula are essential for all of the movements of the arm. For instance, an elevation of the arm above the head is done partly by direct movement in the shoulder joint and partly through the outward rotation of the scapula. For every 10 degrees of elevation of the arm above the head there is a 10-degree rotation of the scapula. Knowing this, it's easy to see why a weak shoulder girdle or a decrease in the mobility of the scapula can lead to shoulder injuries.

The pull-up is a very complex muscular movement.

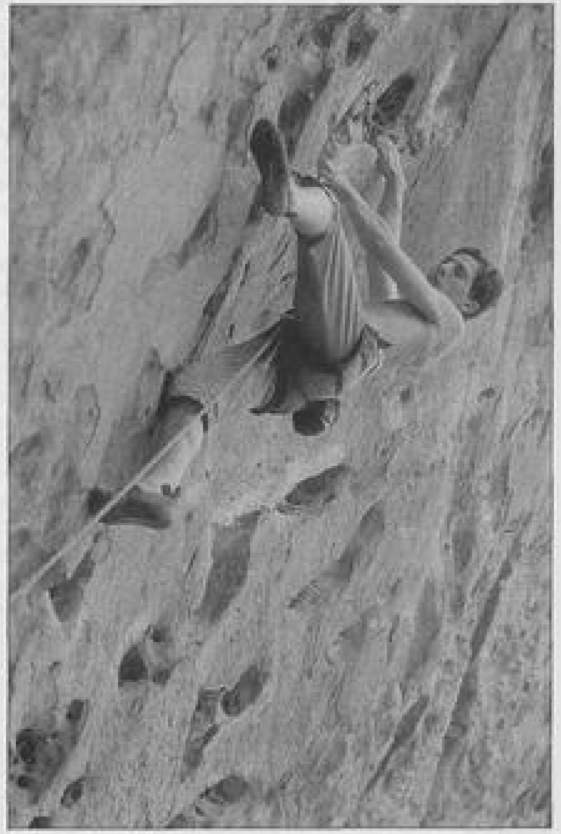
All of this put together is a lot to remember, but it's important for a climber to understand it when training. To see how complicated the body is and how much goes into one move, lets take a look at the simplest of moves. Hanging from a bar and doing a pull-up, something we as climbers take for granted, requires all of the following muscles to work together in a coordinated effort:

1. Superficial and profundal finger flexor muscles for fixing the fingers and hands in an undercling position on the bar.
2. The interosseus muscles slightly spread the fingers to increase the power of the fist.
3. The lumbricales muscles help the flexing of the fingers in the base finger joint.
4. The extensor muscles are holding the wrist in a slightly dorsal extension. This increases the tension of the finger flexor muscles.
5. The thumb muscles, as an opposing digit to the other fingers, complete the hand position with the flexing of the M. opponens pollicis and the M. flexor pollicis.
6. The biceps and supinator muscle flex to supinate the forearm.
7. The brachialis, the brachioradialis, and the biceps muscles, all flex the elbow joint.
8. The rotator cuff centralizes and fixes the humerus in the should joint.
9. The arm is pulled to the trunk and all parts are held in position through the pectoralis major, the trapezius, the serratus anterior, and the latissimus dorsi.
10. The rhomboid muscles activate to help hold the scapula in position.

In one simple motion we have both dynamic and static work being done by many different muscles in a large percentage of the body. It's pretty obvious that climbing power requires a lot more than just well developed forearms.

1.5 Physical requirements

Every sport has a different body type or physical constitution that would give an athlete the optimum performance in just that sport. That is to say, the perfect build for a linebacker on the Dallas Cowboys would be fast and powerful, with large knees, broad shoulders, and powerful legs. Most important as a football player is that he would have to be big. His perfect body constitution as a football player would probably make him a lousy ballet dancer, and there are no ballet dancers in the world that could play linebacker for the Cowboys. Every different sport has its ideal type, and these can even change inside the sport between the various disciplines (a 100 meter sprinter is of a completely different build than a marathoner, though they are both runners). In the early years of climbing the big, powerful build was common, but as the sport has gotten more specialized so have the climber types. This is especially the case in hard sport climbing and competition climbing where the thinnest, lightest athletes are performing at the highest levels. It would appear that for extreme rock climbing (or plastic), the lighter body type has an advantage even though a larger body would have a larger amount of muscle mass.



Lean athletes seem to have advantages in climbing.

There are also abnormalities, diseases, and body forms that would lend one towards a decreased ability in a particular sport. For example, it would be inadvisable for a person with a high axial deviation of the legs (X or O deformity, as in bow legged) to become a runner. The non-axial stress to the knee joints and cartilage consumption would result in an early onset of arthritis.

A weak body constitution in a climber, for instance some abnormalities of the hands and arms, combined with high-stress training and exercise, will dramatically increase the risk of overuse syndromes. A person with very flexible joints is much more likely to develop inflammation of the tendon sheaths (tendovaginitis) of the finger flexor tendons. Through this excessive mobility the cartilage, as well as the non-passive structures like the tendons and tendon sheaths, are put through more stress than they otherwise would endure. Less common than lose joints would be variations in the shape of the bones themselves. One example would be a short ulna in the wrist joint (called a minus ulna). This can lead to a higher level of mobility in the wrist, which can lead to numerous overuse syndromes. Also, thin and long fingers are more likely to suffer overuse syndromes than short and fat fingers.

From a sports medicine point of view, the stresses put on the human body in modern climbing, and the resultant injuries, are often more from our training than from physiological abnormalities. Human fingers and finger joints are not designed for doing pull-ups with extra weight around the waist while crimping a small edge, or doing double dyno's on the campus board. The body tolerates these stresses for short periods, but repeatedly pushing these limits will likely lead to overuse syndromes. However, you're probably going to do it anyway if you want to improve. If so, it's good to be aware of variations in body type when doing certain types of training and modify your workout accordingly.

NOTE

Time of reaction to stress of different body tissues:

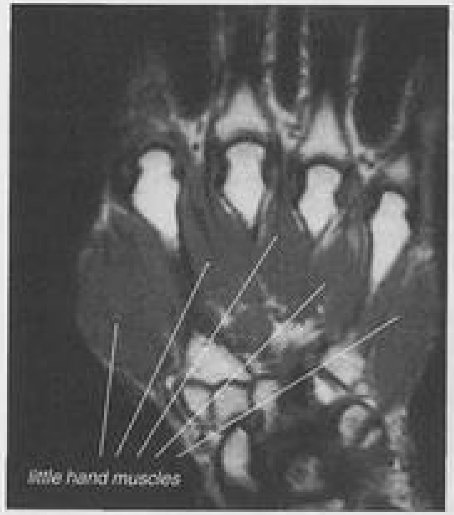
Muscle	after 3 weeks of training
Heart Muscle	after 4 weeks of training
Bone	after 1 year of training
Tendon	after 1 – 2 years of training
Ligaments	after more than 2 years of training
Cartilage	after 3 – 5 years of training

1.6 Physiological Reactions of Bone and Soft Tissue Stress

Even a person with only a slight interest in sports knows that intense power training leads to an increase in muscle size. The nice biceps and pecs of a body builder are a perfect example of this. Of course, the muscles are not the only parts of the body that react to the stress of athletics. The soft tissues that connect everything, and even our bones, react to chronic stress with growth, though these adaptations are not as visible as the nice biceps and pecs. While the muscles grow in just a matter of weeks, adaptations of the tendons, cartilage, joint capsules, and bones take months, or even years, to be noticeable. With X-rays and MRI exams we can see a physiological reaction, specifically an increase in the size of the corticalis of the bones, after years of climbing stress (corticalis is the hard outer portion of the bone that carries much of the load). Also, through X-rays of the insertions of the tendons at the bone, specifically the superficial and profundus finger flexor tendons in the finger joints, we can see the development of bony structures, or ossifications, on the tendon insertion.

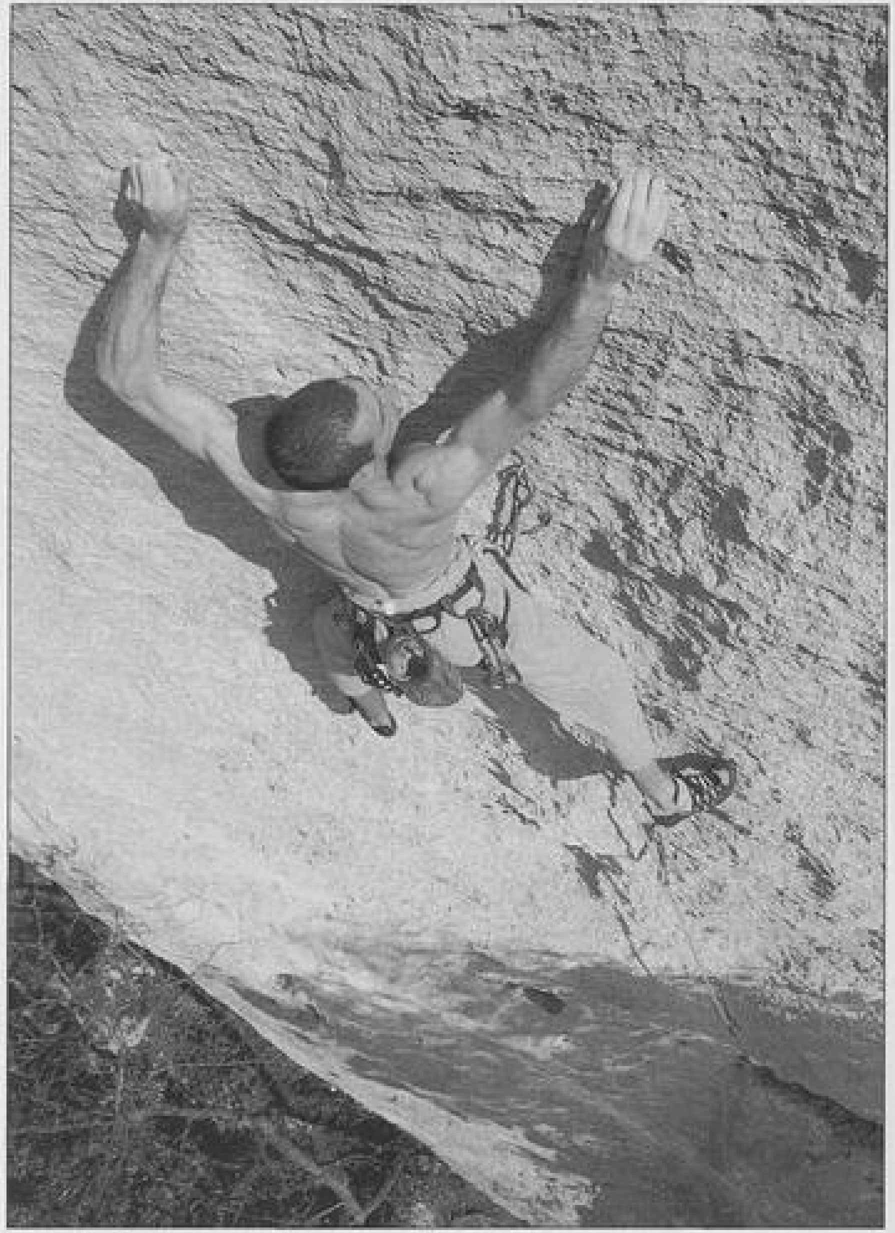
Through years of climbing the corticalis of the bones grows resulting in bone hypertrophy.

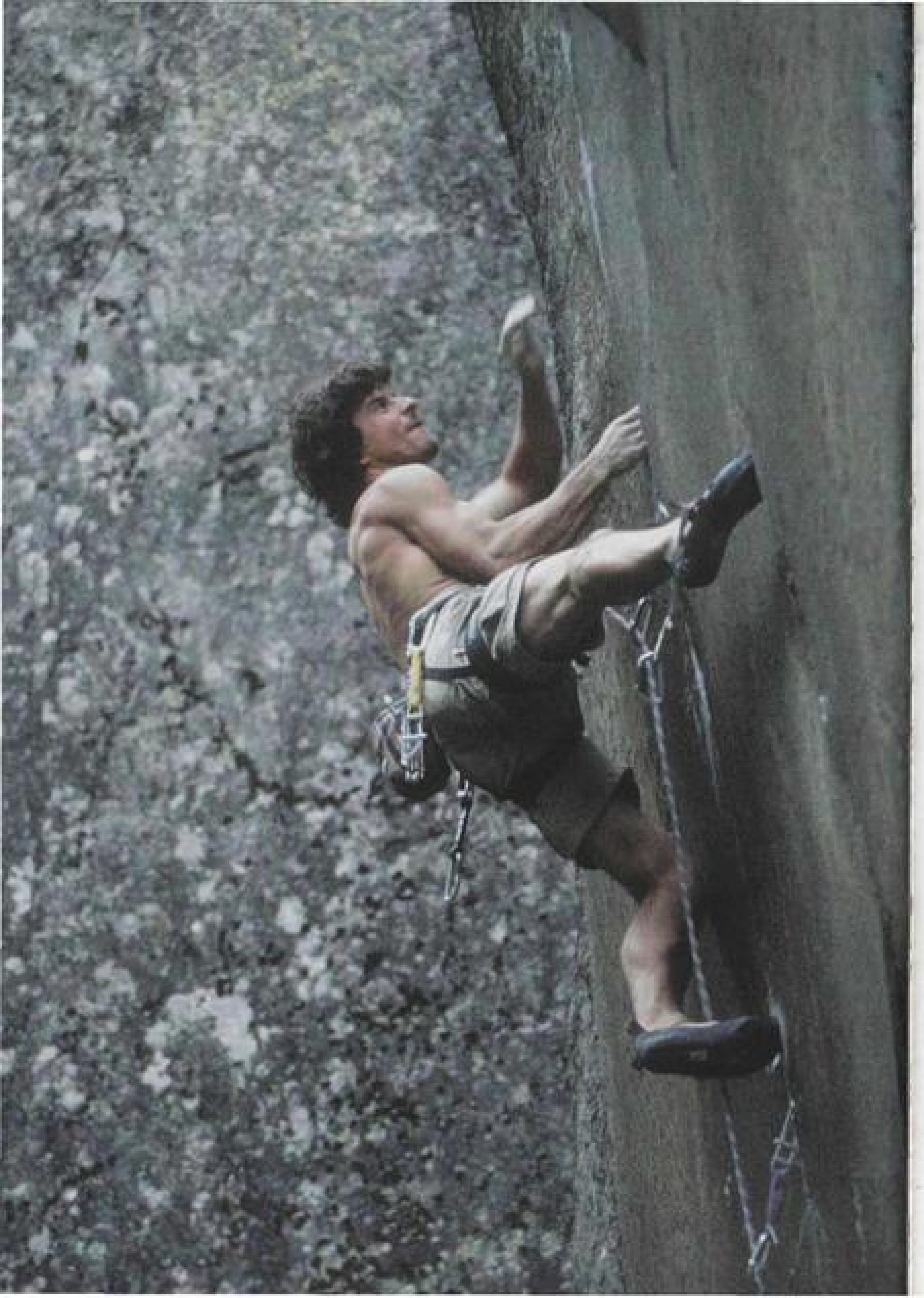
As we said, through an MRI exam we can see interesting stress reactions of tissues in veteran climbers. The collateral ligaments in the interphalangeal joints of the fingers tend to become thicker. Also, the flexor tendons were twice as strong in climbers as they are in non-climbers. In a tendon that is only four or five millimeters in diameter, as the flexors often are, this is quite a difference. After years of climbing many people notice this increase in the size of their fingers and assume this is an increase in muscle mass. Remember, there is almost no muscle tissue in the fingers. This increase in size is actually an increase in the size of all the passive components and the tendons so they can handle the stress of climbing.



The subcutaneous tissue, that is the soft tissue under the skin, is stronger and has an increased blood flow, probably as a result of the permanent and re-occurring pressure-stress of climbing. How long it will take for an individual to see these reactions depends on a lot of variable factors.

An MRI of a long-term climbers hand shows adaptive reactions, specifically the hypertrophy of the little hand muscles (Mm. interossei and lumbricales).





2. Injuries

A survey of injured climbers over the past 10 years shows interesting results:

- Over eighty percent of the injuries and overuse syndromes are concentrated in the upper body
- Over fifty percent of the injuries and overuse syndromes are in the hands
- Sixty-nine percent of the problems were overuse syndromes, thirty-one percent were acute injuries
- Of 284 climbers, 22 needed surgery because of fractures, tendon injuries, or nerve compression syndromes
- Of 284 climbers, 16 complained of recurrent lumbar pain
- Of 284 climbers, 31 had an increase in muscle tension along the spine
- Of 284 climbers, 5 had spinal surgery for nucleus-pulposus-prolaps (herniated disc)
- The most frequent injury was a pulley rupture
- The most frequent overuse syndrome was tendovaginitis of the fingers problems are increasing.
- In comparison to 10 years ago shoulder and feet problems are increasing

Most frequent injuries and overuse syndromesof 284 sportclimbers:

Inflammation of the tendon sheaths	62
Swelling of finger joints	47
Tennis elbow	38
Pulley injuries	37
Nerve compression syndromes	21
Fractures	21
Tendon strains	12
Overuse syndromes of the shoulder	7
Meniscus injuries (knee)	7
Flexor tendon injuries	2

This is a breakdown of the places those 284 climbers suffered overuse syndromes and injuries:

Hand	55
Elbow	18
Foot	8
Shoulder	8
Back	7
Knee	4

◁ *Gerhard Hörhager on "Ganja" (8a+), Zillertal/Austria*

Analyzing climber demographics over the last 10 years we found the following changes:

NOTE

- The best climbers are getting younger
- Climbers are getting thinner
- More climbers are doing warm up and stretching routines
- Eighty percent of those surveyed have a training schedule

Sports medicine makes a distinction between acute injuries and overuse syndromes. Injuries are caused by acute traumas, as in when you are holding a one finger pocket, your foot pops, and you hang onto the pocket and rupture one of the side ligaments and then fracture the bone in your finger! An overuse syndrome is the culmination of long-term stress to a certain area, as in doing 300 chin-ups a day with no rest days and then feeling a burning sensation in your elbows! This chapter will focus on dealing with the acute injuries, while chapter 3 will focus on overuse syndromes.

Accidents in the mountains are often complex and thus hard to place in particular categories, but there is very accurate data available on injuries incurred at indoor climbing gyms. In Europe, indoor climbing walls need to meet certain standards to guarantee they are safe, and the holds are also required to meet standards on their individual safety. In a survey from the United Kingdom only 55 accidents happened in 1.021 million visits to the climbing gym. In our survey of German climbing gyms, where 25,126 visits were reported, only 4 accidents occurred. This means in the UK you have a .06% chance of getting hurt, while in Germany its .016% per visit. Your probably more likely to be hurt driving to the gym than during your workout!

In this survey we referred to an "injury" as any trauma that needed an immediate consultation with a doctor. The smaller and more frequent injuries, like the capsule injuries or strains of the fingers, were not figured into this sections' data.

From a sports medicine perspective, the last few years have seen training for climbing change for the better.
Climbers who are properly training are not taking the "old southern football coach" approach to training, like dropping

themselves from hold to hold until their hands come apart, as they once did. Training boards, a major source of climbing injuries when they first came out, have become less prevalent and are being used in a far more responsible manner than they initially were. Also, the producers of the artificial holds are designing equipment that is less likely to cause an injury. Most athletes that were injured while climbing or training did so in an uncontrolled fall or when an unexpected slip of the foot happened.

Before we start discussing the particulars of each injury, it's probably wise to define a few basic medical terms.

Contusions are the most frequent sport injuries. Contusions happen when the surface tissues are hit or the muscle tissues suffer slight tears after being hit. These tears tend to rupture blood vessels, which lead to visible haematoma. In other words, a bruise.

Muscle strains and tears are injuries where the muscle fibers are actually pulled from one another. It is often difficult to distinguish between a tear and a bad strain as there is a transition point from which a strain becomes a tear.

Distortions occur when a joint is stressed beyond its range of motion but is not completely dislocated. A severe distortion might mean the rupturing of the ligaments where an early diagnosis, and treatment, is essential for proper rehabilitation.

Fractures and dislocations occur less frequently, but they are common enough that we have to address them. A fracture is the breaking of a bone and a dislocation is the moving of a bone from its appropriate location in a joint.

If you are reading this because you just suffered an injury, you might be looking for some sort of remedy. The first thing you should do is see a doctor. Among other things, he is probably going to prescribe R.I.C.E. The acronym R.I.C.E., as in rest, ice, compression, and elevation, is one of the most common ways to immediately deal with an injury.

1. Rest **Rest**

Pain is an alarm. It is a warning that something in the body has been damaged, and you should not ignore it. After any injury you should listen to pain and immediately rest. Keep in mind that the level of pain does not always reflect the level of seriousness of an injury. For instance, a strain of the ligaments of the ankle is often more painful than a complete tear of those ligaments. This is because a strain stretches the pain receptors, while a complete tear actually severs the receptors thus keeping them from sending a pain signal. Often in a complete sever of ligaments the pain comes on later when the area begins to swell.

Ice

2. Ice
Invented over 4 billion years ago, this frozen combination of hydrogen and oxygen atoms has not yet been improved upon. You hear it mentioned every time there is an injury, or after surgery, and for good reason. The cooling effects of ice are as potent as any drug on the market at reducing swelling and blood flow. Following an injury, ice should be applied to an area as soon as possible. The ice, or so-called "coolpaks" (chemical derivatives of the same thing... cold), should be placed on the area for around 20 minutes. After removing it there will be an increase in blood flow, which can be remedied with compression (see below). Avoid placing the ice, or pack, directly on the area as it is easy to frost bite your skin. A thin towel placed between the ice and your skin will serve as a sufficient insulator while allowing the cool temperatures to penetrate. Icy water of about 4° Celsius has proven to be the most effective temperature to safely cool an injury. An easy way to get water to this temperature is to use the "hot ice" technique. Placing ice cubes in cold water does this.

For chronic problems, icing for five to ten minutes has been proven to be very effective. The increased blood flow (reactive hyperemia) following icing is actually the most effective part of the treatment. The drawing in of blood brings in the necessary nutrients for healing, so even the cooling sensation of placing rubbing alcohol on the area can have some benefit. However, alcohol tends to only work on the surface, but the cold of the ice can actually penetrate the tissue.

Compression

3. Compression
The use of compression is only necessary after an acute injury. After icing, the small blood vessels will dilate leading to an excessive flow of blood to the injury. This effect, reactive hyperemia, should be held back from and acute injury with compression. Without the compression the swelling can simply re-occur and the blood flow will be restricted again. Just as a point in fact, compression is recommended, but make

sure you avoid constriction! It is possible to slow the healing by putting a compression bandage on so tight that it cuts off the blood flow.

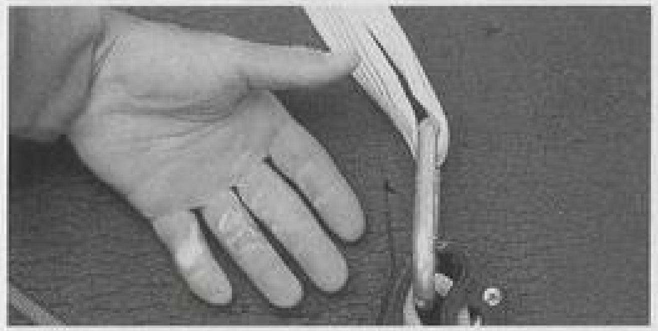
Elevation

4. Elevation
By elevation we mean the act of keeping the injured area above the level of the heart. Elevating the injured limb helps reduce swelling and increases the vascular out-flow from the injury to the central body.

2.1 Skin Damage

Large tears in the skin of the hands and fingers, commonly referred to as "flappers", are pretty common in modern climbing.

Throwing a big dyno and not sticking the hold is a common cause, as is crack climbing on very rough rock or with poor technique.



The incorrect use of modern belay devices can lead to serious injuries. Burns are common, some affecting tissue as deep as the flexor tendons. The healing process can be quite slow for burns.

These scrapes rarely require anything more than a good cleaning, though they can often get in the way of your climbing routine for days. When the injury occurs and there is no way to stop the bleeding, many climbers go to their chalk bag. Pure magnesium/carbonate chalk does a good job of drying out the area and helping it to form a temporary scab. However, no studies have been done on long-term health problems related to this use of chalk, and new additives to chalk may be bad for you. In any case, if you have no other means and you use chalk to help dry out a wound, make sure you clean the area thoroughly so it can heal as soon as you get home. Pay special attention to cuts under the fingernails as they can easily gather and hold dirt.

THERAPY

Initial Treatment of Open Wounds

- Clean and rinse with water and soap
- Disinfect with alcohol, hydrogen peroxide, or betadine
- Cover the area with a sterile bandage or tape it for protection if you must continue climbing

Puss flowing from an infection under the fingernail

More dangerous are burns, and even tears of the *fingers*, that can occur when belaying. Even modern auto-locking belay devices can fail, either through being improperly set up or through lazy handling. Serious rope burns, sometimes affecting tissue as deep as the flexor tendons, are a possible result. Permanent scaring is possible, sometimes causing pain or immobility, perhaps necessitating surgery to clean and disinfect the area and remove excessive scar tissue. Also, keep in mind that an up-to-date tetanus vaccine is essential and should be a kept current in all rock climbers.

Small cuts and abrasions need to be cleaned and disinfected

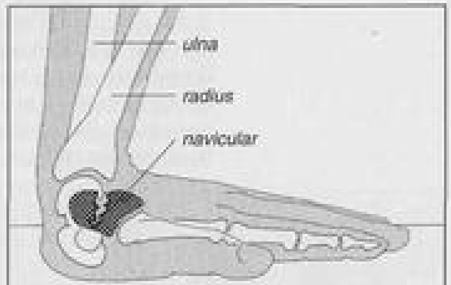
2.2 Fractures

A lot of bones can be broken during a fall, but we will only discuss the ones that are the most common. While fractures of the elbow or the skull do occur when climbing, fractures in the hand and the foot are far more common and specific for the sport.

2.2.1 Fracture of the Navicular (Scaphoid)

The navicular is a small bone in the wrist. In contact sports, and sports where one might fall and try and soften the landing with the hands, this bone is frequently injured. Typically what happens is that when we fall we try to catch ourselves with our hands pulled back, thus hitting the ground with our palms. If the hand is forced back even further than it naturally would go, the navicular can be broken. The common symptoms are pain in the wrist, pressure sensitivity at the base of the thumb, and a decrease in the range of motion.

Typical injury pattern is trying to catch the fall with a hand pulled back.



Typical injury pattern in navicular fracture

Unfortunately, this fracture is often missed in the initial x-rays. Like the other wrist bones, the navicular has a thin solid portion of bone, the corticalis, and a thick section of spongy bone known as spongiosa. If the fracture is in the spongiosa it is very difficult to detect. Sometimes a fracture may not be detectable for a week as during this period the body absorbs the broken down materials and the line becomes more distinct. It is very important for the injured climber to know that just because the initial x-ray did not show a fracture, the bone still might be broken. If the fracture is not treated as such, or is just diagnosed as a sprain, the climber might not get the proper rehabilitation.

SYMPTOMS

Symptoms of Navicular Fracture

- Pain in the wrist
- Swelling
- Haematoma

Without placing the wrist in a protective and de-mobilizing cast it is possible that pseudoarthrosis (non-union) could develop, increasing the pain over the months and bringing about debilitating arthritis. However, if the break is caught, a cast is placed on the injury for 6 – 12 weeks, and therapy is begun, there is a good chance that the fracture will completely heal. Sometimes surgery is necessary. Pay attention to the area after the initial diagnosis and contact your doctor if does not improve.

THERAPY

Therapy for Navicular Fracture

See a physician
Immobilization
Cast therapy or surgery

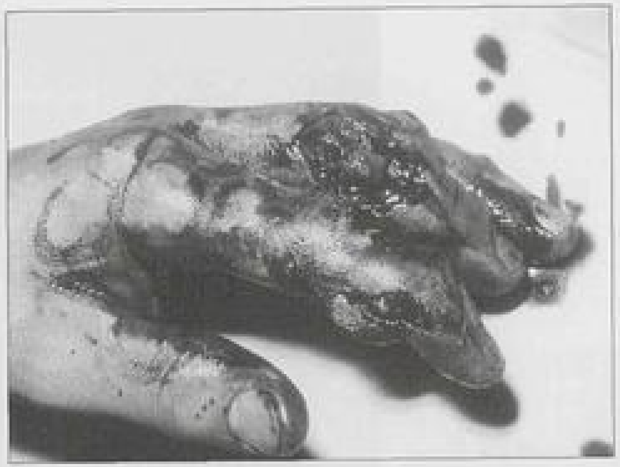
2.2.2. Fractures of the Fingers

A finger, stuck in a finger lock or pocket during a fall, can be badly broken. Generally, a break under these conditions is going to be bad enough that both the joint capsules and the bones will be affected. Often surgery is going to be needed to make the repairs.

A compound fracture of the middle finger phalanx

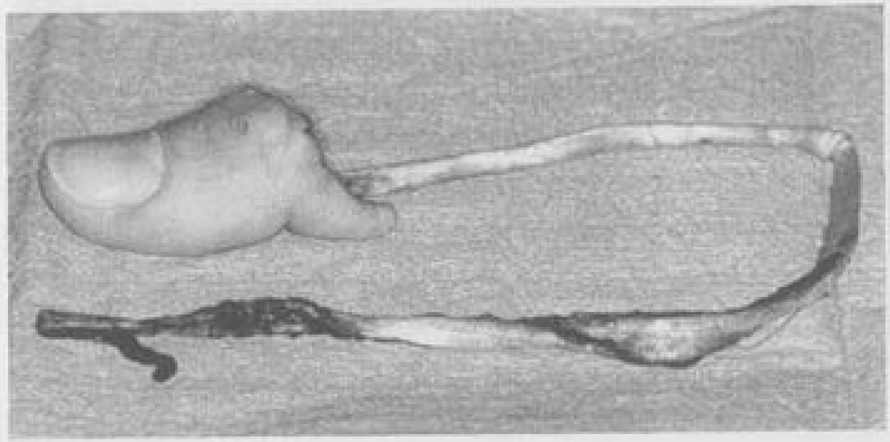
A fall with the finger stuck in a finger lock caused this rotational fracture of the base finger phalanx

Perhaps the worst broken fingers occur when encountering rock fall as the fractures are generally accompanied with massive soft tissue damage. Open fractures often become infected and require plastic surgery for repair.

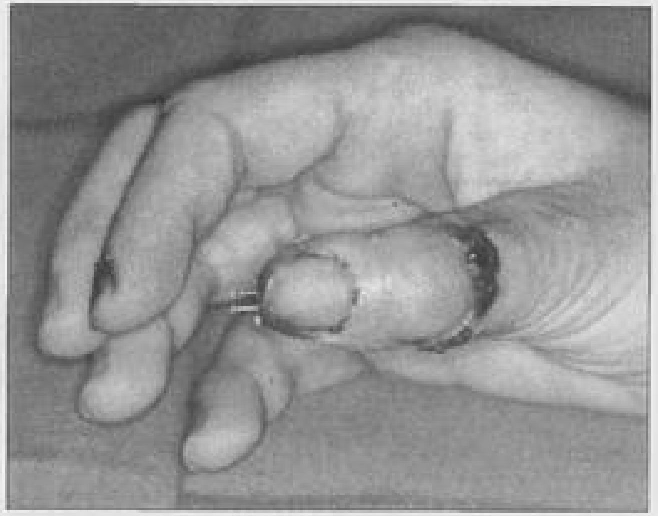


Rock-fall caused this finger fracture and massive soft tissue damage

Falling rocks have completely amputated fingers and entire hands. It is possible, theoretically, to lose a finger in a very sharp crack or finger pocket, though generally this is not the way severe hand injuries happen. The most common way to sever your fingers and hands is to grab the rope when falling. When you grab the rope below you while falling, the rope can twist around your hand or fingers and forms a lasso. As the cord tightens up, the lasso sinches down on your digits and squeezes them. A big fall can squeeze hard enough to tear them off. In one recorded event a climber's thumb was torn off.



Amputation of the thumb caused by the rope



The thumb reattached – she climbs 5.12 d's again.

2.2.4. Fractures of the Lower Extremities

For the purpose of explaining the different ways injuries occur while climbing, we are distinguishing here between two different types of falls. A wall-collision fall is one where the climber impacts the wall in a more or less vertical plane, while a ground fall is one where the climber impacts in more or less the horizontal plane. In this definition a fall where the climber hits a small ledge will be defined as a ground fall.

Dislocation fracture of the ankle after a 9-meter-fall

A ground fall from as little as 8 feet high can lead to serious fractures of the calcaneous (heel bone) and ankle joint. Distortions of the ankle, with a total rupture of the ligaments or an ankle dislocation and fracture, are the most common breaks. These injuries are on the increase with the growth in bouldering as a sport, but they are also fairly common with sport climbers who fall before reaching the first bolt or are dropped by their belayer. The calcaneous and talus bones are similar to the navicular in the wrist in that they have a large amount of spongy tissue. Again, seeing the fracture on an x-ray is often difficult. Injuries in these bones are often followed by a long recovery time with lots of therapy. The lack of good blood flow to the bones, a problem that is exacerbated by the trauma of the injury, increases the healing time. In a compound fracture, (where the bone is pressed together from the impact), the talus tends to lose blood flow to such an extent that it can become necrotic (decaying). These fractures usually require surgery for repair and can mean up to 12 – 16 weeks of non-weight bearing treatment. Blood flow disorders, long term swelling, and early onsets of post-traumatic arthritis in the ankle can follow these injuries.

A ground fall from very high almost always leads to injuries, if not death, but a collision with the wall, where the rope actually pulls the climber into the vertical plane of rock, can also cause serious injuries. Contrary to how it might appear, short falls, with a high impact factor (generally not far from the ground or the belay) can be the most dangerous.

When falling, even in a short fall, the rope can pull the climber into the rock and create a dangerous collision with the wall.

Contusional fractures of the foot are not uncommon, one of the authors just ruptured his achilles tendon like that.

In these types of falls the climber is actually pulled back into the rock and the angle that he/she puts the foot at on impact creates a lot of stress on a particular spot. Also, auto breaking devices, if used in a wrong way, can increase the fall factor. It might be prudent, in certain situations and when using these devices, to actually jump up as the rope comes tight in the device. This can help to lessen the intensity of the "stop" and thus make the swing into the rock less severe (An instructor should teach you how to do this. Do not attempt it if you have not been shown how by an instructor). The most common injuries with this type of fall are contusions and contusional fractures of the foot, both of which will require immobilization and a quick trip to the hospital for diagnosis. Again, keep in mind that the fracture of the calcaneous bone might be hard to see on x-rays so the initial diagnosis might not be correct.

Essentials for Safety

- When bouldering, always use a crash pad. Make sure the pad is under the problem and not in the optimum place for sunbathing

- You should always boulder with a spotter

- For indoor climbing gyms the boulder mats should be at least 30 cm thick as it is common for the climber to fall completely out of control.

- The mats below the lead walls should be thinner, like 5 - 10 cm

- Close the cuts between mats with Velcro straps or carpeting

- Remember that when belaying, a shorter fall is not always the safer fall. "Sucking the climber in", the act of taking in the rope during the fall, could pull the climber into the wall and cause the injury. This is especially the case on slabs and when the climber is closer to the belay. However, a longer fall that results in a ground fall is almost always worse.

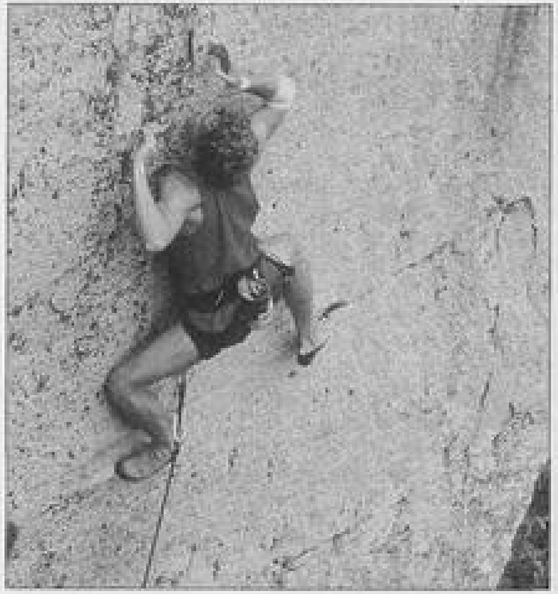
As mentioned above, the more serious fractures are those that are open or compound. These wounds can easily become infected and generally require immediate surgery (hard to do when you are someplace like the Karakorum Valley of Pakistan!).

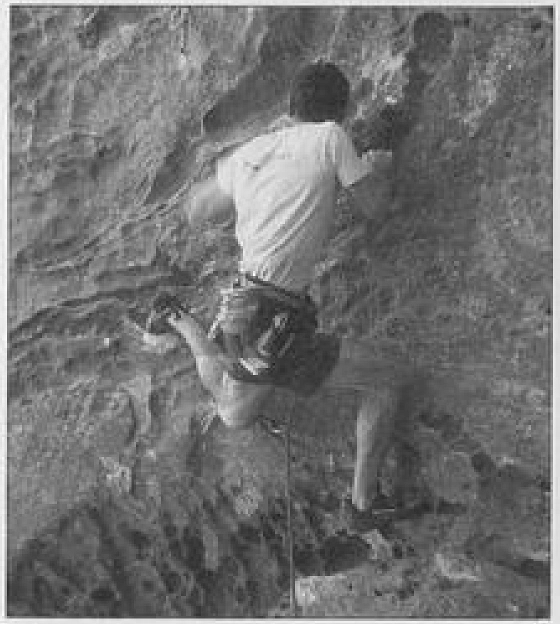
If you think you or your partner might have a fracture, its important to elevate the leg and immobilize the break so as to slow the swelling and building of haematoma. Inexpensive, light splints should be a part of your first aid kit, but if you don't have a manufactured splint, a little creativity will fashion one. We have seen splints made from sticks, ice axes, and even AK47's (unload first). If the fracture is accompanied with a dislocation, as is often the case, a non-medically trained person should not try to realign the joint. Professional medical care needs to be found as soon as possible, noting that the longer the wait and the transport time, the more complications are likely to ensue. The injured climber should not drink, eat, or smoke as there is a good chance surgery will be performed that day and these things will complicate the use of anesthetic (oral pain killers with a small sip of water are generally allowed, but still may complicate surgery).

2.3 Injuries in the Knee to the Meniscus

Sport climbing has changed many of the ways we move over rock. Perhaps because of the changes in how we use our feet there has been an increase in the number of injuries to the knees. The meniscus, a shock absorber in the knee lying between the femur and your lower leg bones, is put under serious strain in a couple of positions we climbers regular get into.

The so called "Frog Position", a stance with the feet on as high as possible and the knees turned out, is an excellent way of lowering your center of gravity while keeping your weight over your feet. It's also an excellent way to put your meniscus under severe strain. This position is achieved with an outward rotation in the hip joint while the knee is flexing. When the knee is flexed and bent over 90 degrees there is serious compression between the two contact points in the joint. The meniscus is designed to take the strain, but when you add in the twisting motion that comes with the outward rotation of the hips, the medial meniscus is put under even more strain than the rest of the meniscus. This difference can cause a tear.





The foot position known as "The Egyptian", or "Drop Knee", is perhaps even harder on the meniscus. When doing the drop-knee, an inside rotation of the hip joint is performed while putting as much weight as possible on the foot. The position is sought because, like "the frog", it lowers your center of gravity, but it also allows the foot to pull you into the wall. With a really good foothold, as are commonly found in a climbing gym, that leg can be taking a lot of weight. The lower back, the legs, and shoulders end up taking a lot of the force that would otherwise be placed on the hands, but this means that force is focused on the foot... and the knee.
Again the medial, or inside meniscus is compressed and put under a twisting force. Its half-moon shape, meant to help in the shock absorbing, makes its edges even easier to tear.

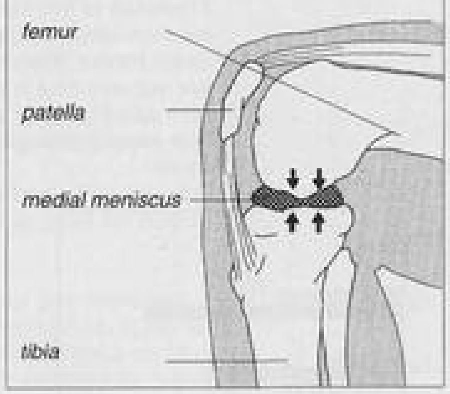
*Above:
The "Frog Position" is an excellent way to put the meniscus under severe stress*

*Below:
The "Egyptian position", or "drop knee", places a lot of stress on the medial meniscus*

The lateral meniscus, that being on the outside of the knee, is thinner and not as tightly attached to the joint capsule, so it is not put under as serious of a strain as the medial.

Sometimes a tear in the meniscus can only be identified with special diagnostic equipment, like an MRI, and even then it is can be difficult to see. Occasionally the tear cannot be seen without arthroscopic surgery. Small tears on the edge of the meniscus need to be treated surgically as, like a small tear on the edge of a sheet, a little nick can rip all the way across the meniscus. This can lock your knee in a certain position, a bad thing when on an expedition, and even lead to more damage of the joint (cartilage damage). Early repair of a mild meniscus tear can often be done with surgical stitching, though sometimes a partial removal of the meniscus is necessary.

injuries of the medial meniscus



In extreme flexing positions of the knee the medial meniscus can be squeezed and injured.

SYMPTOMS

Symptoms of Meniscus Injuries

- Pain when placing the joint under stress
- Sharp pain on the inside or outside of the knee
- Pressure pain on the medial joint area
- Blocking of movement, or "locking" of the joint
- Swelling
- Pain increasing when over flexing or over extending the knee joint

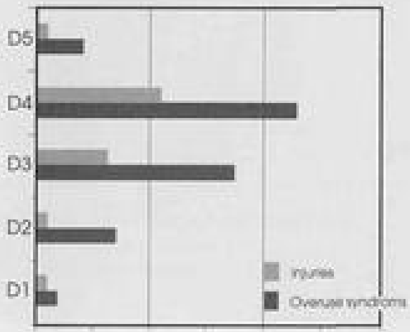
THERAPY

Therapy for Meniscus Injuries

- Arthroscopic surgery

2.4 Injuries to the Pulley System

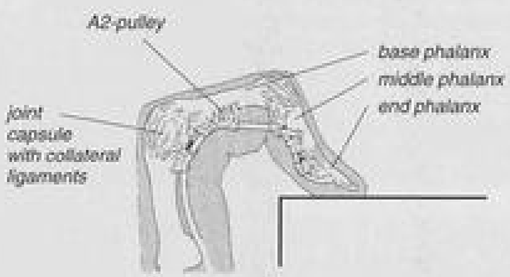
Fractures of the hand and foot are not the most common injuries in rock climbing. The most common injuries are to the flexor tendon sheaths and the pulley system in the fingers. In our surveys one in every four climbers, on average, has had an injured hand or finger that required a long recovery time. The most common place these injuries occur is in the ring finger.



Injuries and overuse syndromes to the fingers: D1=thumb through D5=pinky. The ring finger is affected most often.

Understanding a bit more of the anatomy and physiology of the fingers clarifies why this is so. The index finger is supported by the thumb on its outside, and the middle finger to its inside. Strong fingers on either side support the middle finger. Unfortunately, the ring finger is only protected by the short and relatively weak small finger to its outside. The natural position of the hand when crimping is with an inward rotation, thus placing most of the force on the index and middle finger. However, in two or three finger pockets, or on edges that are held in an open hand position, the ring finger is placed under more strain. The combination of this lack of support, shorter length, and placement of force on certain kinds of holds, makes the ring finger the most frequently injured of the fingers.

Pulley injuries caused by full tension of the flexor tendons *(crimping)*



In the crimping position the A2 pulley is put under maximum tension

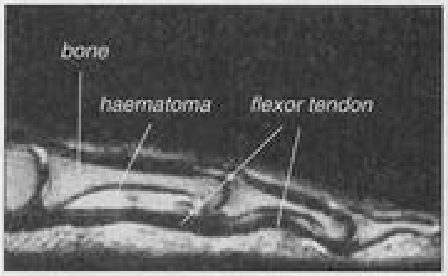
Most climbers tell of the same series of events that led to the injury:

- The feet suddenly slipped off, increasing the load and force placed on the hands that were crimping a hold, but the climber hung on anyway
- A fast and dynamic pull on a small edge
- Dynoing from edge to edge, or twisting the fingers into pockets
- Repeating the same motion over and over. This is most common when the campus board is being used for double dyno's at the end of a training session

Nearly everyone says that when the pulley tore there was a ripping, or popping sound. This can be heard from some distance, and I have even heard one (at Smith Rocks on Darkeness at Noon) that sounded like a .22 caliber rifle being fired!

Swelling and a haemotoma at the base phalanx of the ring finger, combined with a reduction in mobility and a fair bit of pain, are pretty sure symptoms that there is an anatomical structure injured in the finger. If you suffer from the above symptoms and have just done one of the previously mentioned exercises, you should not continue climbing.
This combination probably means you have injured the A2 pulley of the flexor tendon sheath. Just saying "Ah, what the hell… I'll tough it out", might cost you a lot more climbing days than you will lose if you just go see a doctor! The faster you get an exact diagnosis and begin treatment, the sooner the healing process can begin and the sooner you will be back on the rock.

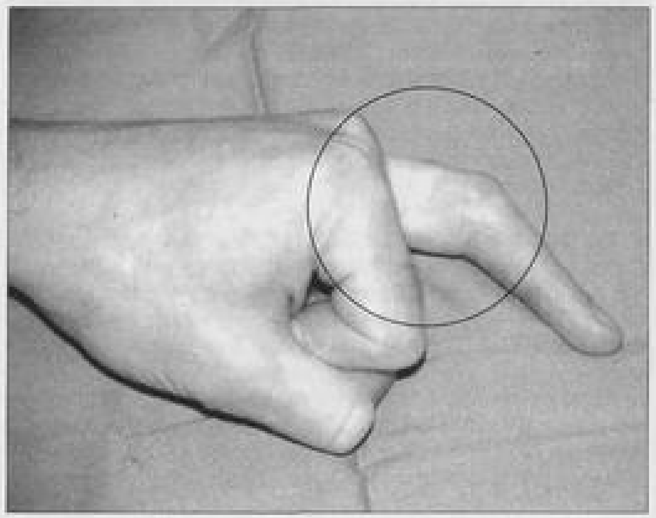
In the long list of people suffering similar injury patterns, we found partial or total ruptures of the pulley and ruptures of the pulley sheath were common, while an actual rupture or strain of the flexor tendons themselves was fairly rare. Noting the size of the pulleys and remembering the extreme stresses placed on them when climbing can explain the high number of injuries to the pulley system. It's an anatomical wonder that something as small as this pulley can hold the loads we place on it. Most climbers are shocked to see (during surgery) just how small this pulley is.



An A2 Pulley rupture as seen in an MRI. Normally the flexor tendons are held close to the bones, but in this photo there is a gap between the tendon and the phalanx. The white is haemotoma between the tendon and the bone.

Diagnosing this injury can be difficult as the symptoms are sometimes only felt under stress and not when in a resting position. Most athletes don't show these problems to a doctor until weeks, or even months, after the injury has occurred. Sometimes they never bother with a medical diagnosis, and not treating the injury as such can result in a prolonged injury and longer recovery time. All finger injuries, especially those with a haemotoma and swelling, are to be taken serious.

Immediately following the trauma, your doctor will probably want to immobilize the finger for up to 14 days with an external splint. This will help speed up recovery because the tendon sheaths, as described in Chapter 1, are an important medium for bringing nutrition to the area. This immobilization will help to allow the free-flow of the necessary healing elements and keep the area from being damaged further. Tears of the A2 pulley that are diagnosed and treated immediately have a very good prognosis for healing. Usually the climber can be back on the rock within 2 – 4 months.



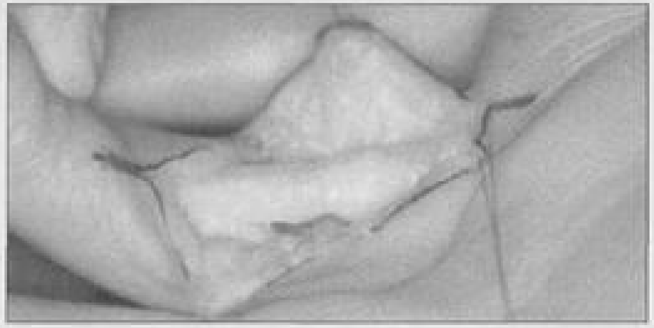
Visible bow string after A2 and A3 pulley rupture

Grading/Therapy tablet for pulley injuries
(Schoeffl-Hochholzer-Grading System)

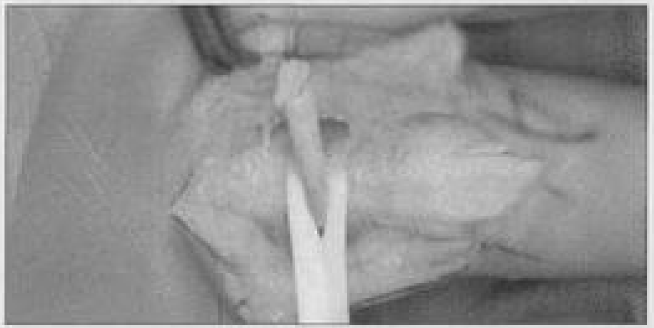
	Grade I	Grade II	Grade III	Grade IV
Injury	Pulley strain	Complete rupture of A4 or partly rupture of A2 or A3	Complete rupture A2 or A3	Multiple ruptures, as A2/A3, A2/A3/A/4 or single rupture (A2/A3) combined with *Mm. Lumbricales* or ligament trauma
Therapy	Conservative	Conservative	Conservative	Surgical Repair
Immobilization	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 ring	Thermoplastic 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

An ultrasound examination can often clarify whether the pulley has been strained or ruptured, though sometimes an MRI is necessary. There is a chance that the injury to the pulley has been accompanied with other injuries. A pain on the side of the middle phalanx could mean that the flexor superficialis tendon insertion was damaged as well. A single ruptured pulley can be treated non-surgically, but in rare cases the A2 and A3 pulleys are both ruptured. If more than one pulley is ruptured, the flexor tendons are not in a stable position and a lot of the function of the fingers is lost. In the case of multiple complete ruptures, surgical reconstruction of the pulley is necessary. The pulleys that have been damaged can generally not be stitched together, but instead need to be replaced with a transplant, usually taken from the M. flexor palmaris longus (in the palm of your hand). These operations require a lot of work from the surgeon and a lot of will to recover from the patient as the recovery time is long and difficult.

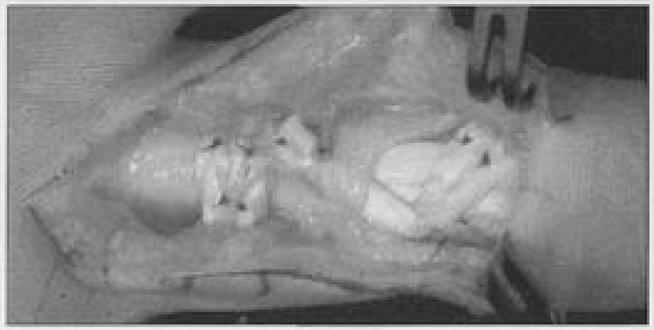
Visible bowstring after rupture of A2 and A3 pulley



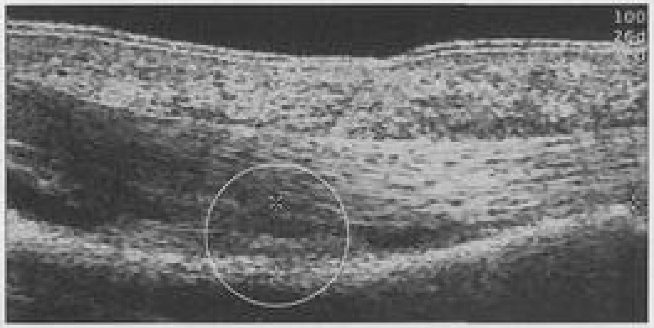
Reconstruction of A2 pulley using the one and a half loop technique



A Weilby's repair for the A3 pulley completes the reconstruction



This is a pulley rupture as seen through an ultrasound exam. The white crosses mark the distance between the flexor tendon and the bone. Normally it's less than 2 mm, but here it is 4 mm.



Ultrasound exams show that pulley ruptures heal with the building of some scar tissue, but the distance between the flexor tendon and the bone is usually consistent. In the long term this does not cause a reduction in mobility or a loss of power, but there is a loss of power just after the injury. This initial power deficit is caused by the change in the mechanical advantage given by the pulleys. After a while the body solves the problem, probably by a little shortening of the muscle, and the normal power level will be gained again.

SYMPTOMS

Symptoms of a Pulley Injury

- Popping sound with pain
- Swelling at the base finger phalanx
- Haematoma
- Pain when moving the finger
- Limited mobility
- A noticeable protrusion (bowstring) of the tendon

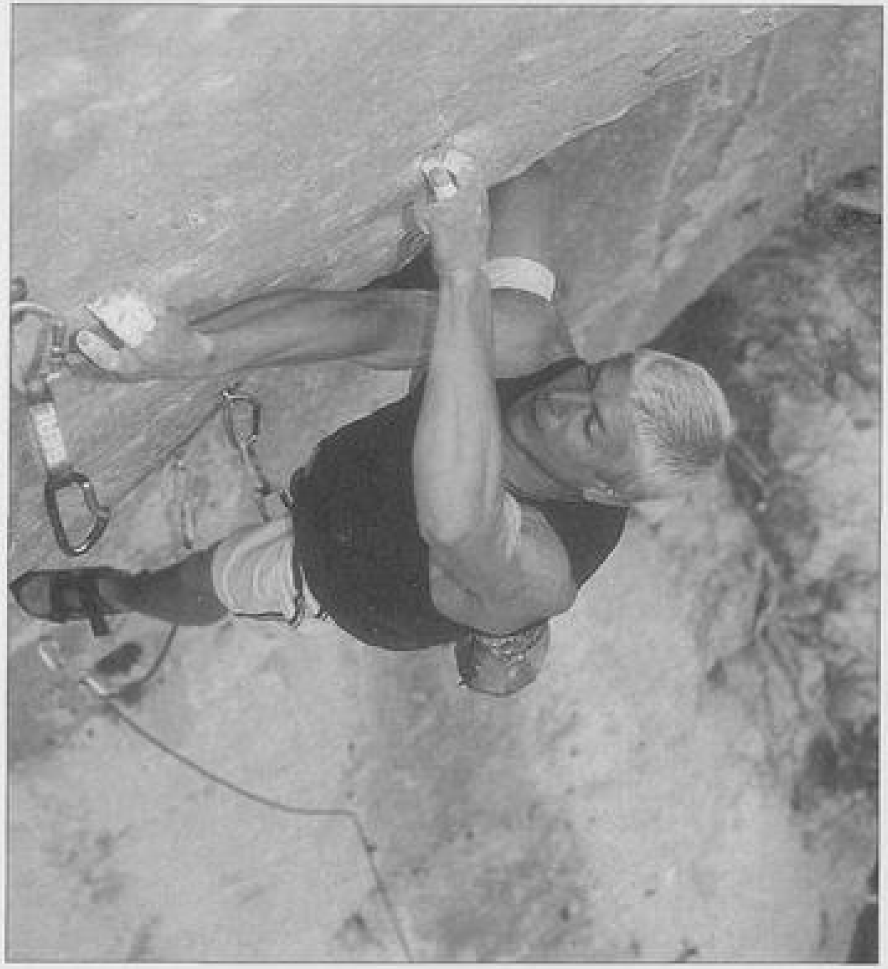
THERAPY

Therapy for Pulley Injuries

- Immobilization with a splint for up to 2 weeks
- Non-steroid antiphlogistical drugs (ibuprofen, aspirin, etc)
- Ice
- Intensive rehabilitation
- No climbing for 4 - 16 weeks
- Tape for half a year following the injury (see chapter on taping for more details)
- Surgery is rarely necessary (only with multiple ruptures)

2.5 Collateral Ligament and Capsular Injuries

When twisting fingers into a pocket, it is more likely you will injure the collateral ligament or the joint capsule than the flexor tendons. There is a constant transition from a sprain to a complete rupture, with the diagnosis made when looking at the symptoms and given lack of ability. The treatment can range anywhere from a splint, to a cast, to surgery, depending on the severity of the injury.



Surgery is required if the collateral ligament breaks off, with a piece of bone, at its insertion. In an over extension of the middle finger joint, which can happen when the fingers get stuck in a pocket and cannot be pulled out during a fall, the joint capsule can tear off a piece of bone on the flexor side of the fingers. These injuries are often difficult to see and diagnose, and can lead to long-term restrictions in your ability to flex and extend your fingers. Anytime a haemotoma occurs with a finger injury, you need to see a physician and have X-rays to make sure these injuries have not taken place.

SYMPTOMS

Symptoms of Collateral ligament and Capsular Injuries

- Swelling
- Pressure tenderness
- Limited range of motion
- Instability of the Joint

THERAPY

Therapy of Collateral ligament and Capsular Injuries

- Initial immobilisation
- Tape
- Surgery is rarely necessary

Opposite Page:
Twisting fingers in pockets can result in injuries to the joint capsule and the collateral ligaments
(Benedikt Hager on "La Chiquette du Gral" (8b+), Buoux/France)

2.6. Muscle Tears and Tendon Strains of the Fore-arm

In comparison to injuries to the pulleys or tendon sheaths, strains and tears of the flexor muscles and tendons in the forearm happen infrequently. A strain is defined when small tears of the muscle fibers occur and is all but impossible to detect. However, an actual rupture of the muscle leaves an indentation that can be felt by touching the area with your fingertips. Every motion made in this condition is so painful that it's almost impossible to use the hand.

SYMPTOMS

Symptoms of Muscle Fibre Tears

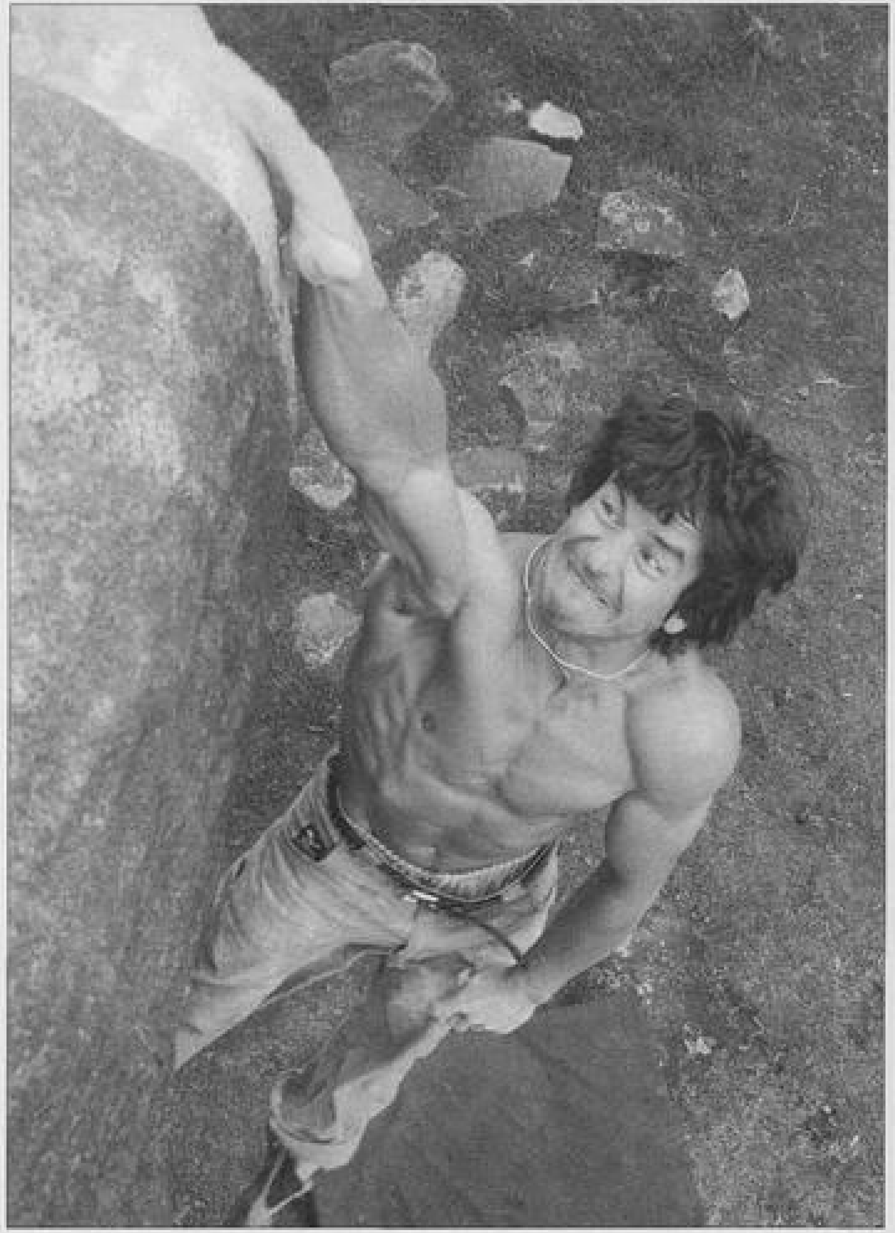
- Pressure sensitivity
- Mobility is reduced and is extreme painful
- There is a palpable indentation in the muscle
- Haematoma

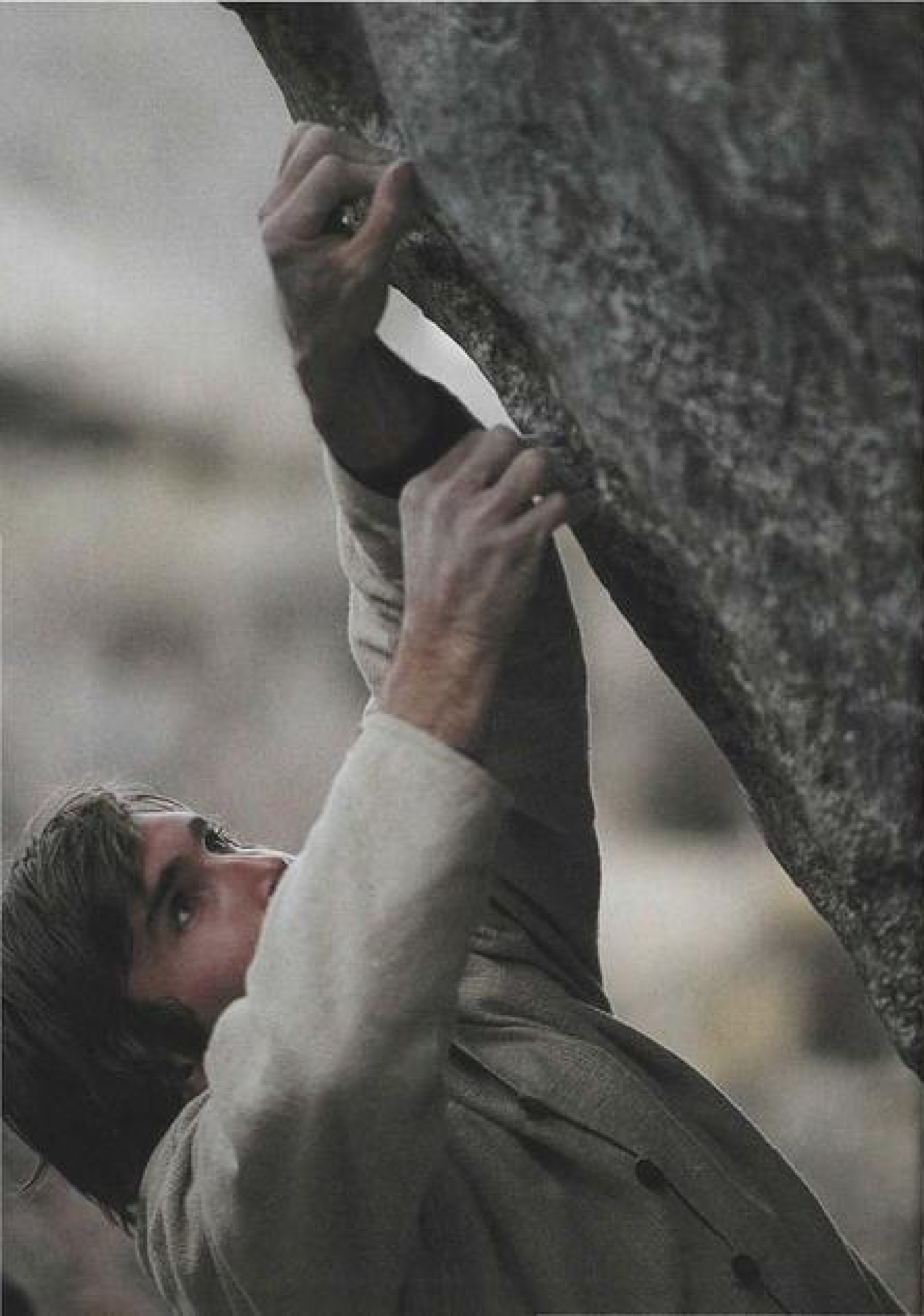
Muscle fibre strains require a rest of at least two to three weeks. Once you have reached a point where there is no pain, the arm can be stretched and some mild massage can be done. However, in the early stages it is important that the arm not be massaged. With muscle fibre strains a haematoma forms inside the muscle where soft tissue begins to regenerate. This will become muscle scar tissue, which is less flexible than the original muscle tissue. If the haematoma is broken down by massage it will not have the chance to become muscle scar tissue. Once the scar tissue has formed it needs intensive physiotherapy and stretching to regain its normal function.

THERAPY

Therapy for Muscle Tears

- No stress for 2 - 3 weeks
- Ice
- Antiphlogistic ointment dressing
- Non-steroidal antiinflammatory drugs
- After 3 weeks you can begin stretching and physiotherapy
- Electrotherapy and injection therapy





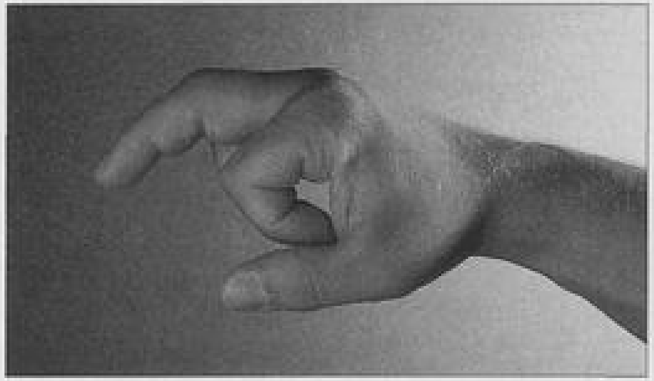
3. Overuse Syndromes

If you do not keep a balance between what is reasonable for your body and what is excessively stressful for your body, you will develop an overuse syndrome. We refer here to overuse syndromes as being those injuries that take time to develop, usually because you have pushed yourself so hard that a number of very small injuries have amassed into one big injury. Generally, these small injuries are accumulated in the tendons, tendon sheaths, and joints, as these connective tissues do not develop at the same speed as the muscles placing stress on them. Serious overuse syndromes with continuous stress on the injured area can lead to irreversible defects. However, most overuse syndromes can be treated and cured if detected early and approached with the right therapy.

3.1 Tendovaginitis

I know; you want to laugh at that word! It sounds like something off the Workman's Compensation form of an over-the-hill porn star. Actually, it is the correct term for what we climbers generally refer to as "tendonitis". Technically, tendonitis is the inflammation of the tendons, while tendovaginitis, which is more common, is the inflammation of the tendon sheaths. Remember that the tendons, the tendon sheaths, and the ligaments (pulleys) form a functional unit. When stress is placed on those tendons, it is also placed on the sheaths and pulleys. Too much high impact stress on the tendons has adverse effects on the tendon sheath and leads to inflammation. This inflammation of the sheaths constricts the tendons, which impairs their movement and thus adds to the irritation. The body will produce more fibrin to lubricate the sheath and tendon, inflaming the region even more. Adhesions will follow, which will lead to a narrowing of the tendon sheath. The long-term consequences are that the narrow sheath is easily inflamed thus regularly reproducing the effect. Tendovaginitis is about the worst vicious circle a climber will face!

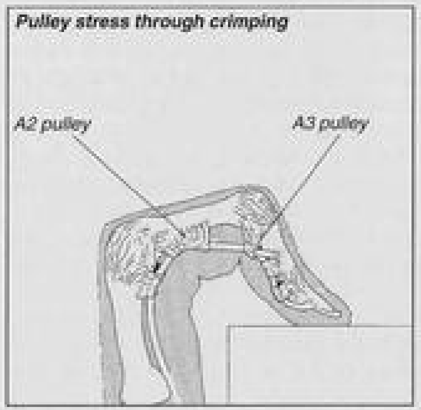
◁ *Chris Sharma*



Excessive tendovaginitis of the middle finger. The area has extensive swelling of the soft tissue and is tender to pressure. A full range of motion is impossible.

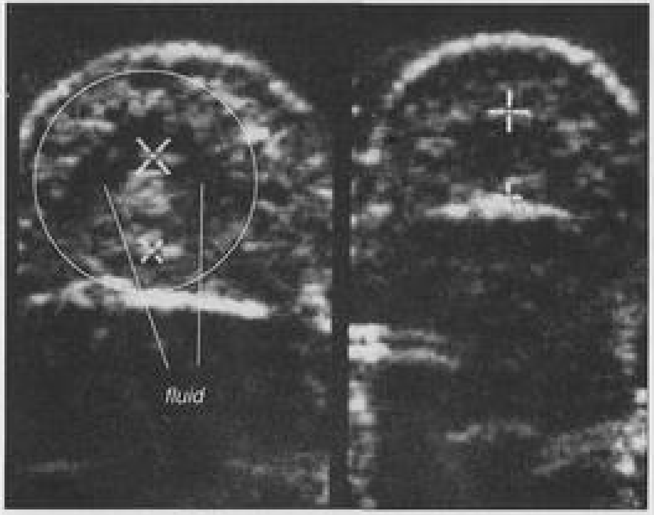
A constant irritation and pain (from inflammation) is what characterizes chronic tendovaginitis. Every move or use of the tendon will be accompanied with a dull ache or stinging pain that radiates along the tendon. The inflamed part of the tendon sheath, and often the tendon, will swell and become very sensitive to pressure (once the tendon swells the condition is tendonitis). The skin covering the area can also become puffy and show where the swelling is occurring.

The most common area to suffer tendovaginitis in athletes is in the flexor and extensors of the forearm, but sport climbers, who put an enormous amount of stress on their hands, commonly have it in their fingers. The middle and ring fingers tend to suffer the most. A good analogy to the tendons, and the conditions that lead to tendovaginitis, is the brake cables on a bicycle. Like your tendons, the cables are put under their greatest stress, and therefore breakdown the fastest, where they make 90 degree bends. In the crimping position you put a similar bend, complete



The pulleys wrap around the joints to reinforce the tendon sheath and keep it close to the bone. Friction and severe strain when crimping can lead to tendovaginitis.

with friction and a mechanical advantage that multiplies the pressure, on those tendons. The winter months, when intense indoor training takes place and most outdoor climbing is done in cold conditions, are the most common time to have tendovaginitis start. Bouldering, where the crimping position is commonly used, is especially stressful on the fingers and their connective tissues.



Ultra sound pictures of a healthy finger and a finger suffering from tendovaginitis. The black halo that is visible around the tendon shows there is an increase in fluids (inflammation) inside the tendon sheath.

The symptoms associated with tendovaginitis and a pulley rupture are quite similar, so the pulley rupture must be excluded before the tendovaginitis diagnosis can be reached. This can easily be done with an ultrasound examination of the injured finger (picture). Just to confuse the diagnosis process, the symptoms of tendovaginitis can come on just as suddenly as the pulley rupture. However, usually a pulley rupture comes with the slipping of a foot or perhaps the fingers popping off a hold, putting an instant increase of pressure on the tendons. The onset of tendovaginitis can come simply by repeatedly grabbing the hold. The clicking or popping sound that is often heard with a pulley rupture is not associated with tendovaginitis.

Again, tendovaginitis in the fingers is an overuse syndrome specific to climbing. However, this same inflammation in the flexors and extensors in the forearm can be associated with sporting activities like gymnastics or even work related activities like typing. After suffering the condition for a couple weeks a noticeable grinding or cracking sound might be heard. This should not be ignored! If the injury has reached this point it should be treated by a physician. Without treatment it will most likely become permanent, or at the very least, a re-occurring problem. A bad case of tendovaginitis can restrict your hands so much that your everyday lifestyle has to be altered. Try going through life without being able to pick up a spoon!

CAUSES

Causes of Tendovaginitis

- Crimping of the fingers
- Repetitive one-sided stress (e.g. Campus board)
- Not enough rest between workout sessions (indoor training, bouldering)
- Climbing when exhausted

SYMPTOMS

Symptoms of Tendovaginitis

- Dull ache in the hand
- Pain during motion and strain
- Grinding sound in the tendon sheath
- Swelling, occasionally redness
- Pressure sensitivity of the flexor tendons

The treatment for tendovaginitis is to place the finger or wrist on a splint and rest it for a week or two, and then spend another week or two taking it easy. The healing process can be sped up by taking anti-inflammatory medication (e.g. ibuprofen, diclofenac, etc), icing, and sometimes heating (see Chapter 6). Remember that just because the pain is gone, does not mean the tendon sheaths have healed. The relief from the pain simply means that the area is no longer inflamed, but time is still needed to let the micro tears that caused that inflammation heal. Chronic cases sometimes need anti-inflammatory injections (low dose cortisone mixed with a local anesthetic) into the tendon sheath. Injections often relieve even the most painful cases, though the worst cases may have residual effects such as a weakening or loosening

of the ligaments and joints. Taping the fingers and the wrist can often reduce the pain associated with the syndrome and help towards recovery.

THERAPY

Therapy of Tendovaginitis

- Rest
- Immobilization with a splint
- Anti-inflammatory medication (oral/ointment)
- Injection of anti-inflammatory medication into the tendon sheath
- Tape
- Ice rubs
- Brush massages
- Sulfur baths
- Electrotherapy
- Acupuncture

3.2 "Trigger Finger"

Trigger finger is the name given to a condition that manifests itself in a number of ways but tends to have one particularly noticeable symptom. If you find that your finger tends to stop and then snap past a particular point, for instance when trying to curl your first finger and it pops as if you just pulled the trigger on a gun, then you have trigger finger. That description also explains its knick-name, and you can see why it might have been a deadly condition to suffer from in the Old West.

A "knot", or nodular thickening, at a particular point in the flexor tendon, can cause trigger finger. The thickened area is often created by chronic overuse or a series of micro-tears to the tendon that have healed with an excessive amount of scar tissue. A serious tear of the tendon can also heal with a lot of scar tissue, or the tendon sheath itself can swell (tendovaginitis) and "grab" a slightly thicker part of the tendon. In any event, when this wide spot in the tendon attempts to pass through the tendon sheath or past a pulley (usually the A1), it gets caught. In severe cases the finger simply won't move past a certain point.

SYMPTOMS

Symptoms of the "Trigger Finger"

- The Finger gets caught and snaps past a certain point
- Pressure sensitivity of the tendon
- Tendovaginitis symptoms
- Palpable "Knot" of the tendon

The area is often associated with pain as this condition inflames the tendon sheath. Vigorous massage can break down the knot, but sometimes an injection into the tendon sheath of cortisone-steroid (corticoid) is required to shrink its size. Your doctor should be very careful injecting the tendon sheath with corticoid as an injection into the tendon, rather than the tendon sheath, can cause necrosis of the tendon and an eventual rupture. If the injection fails to relieve the problem, surgically splitting the A1 pulley is often necessary. Your A1 pulley is actually in your hand and is not necessary for normal finger functions as the A2 pulley holds the tendon in place when the fingers bend. However, by cutting the A1 climbers usually notice a slight decrease in power for a limited time

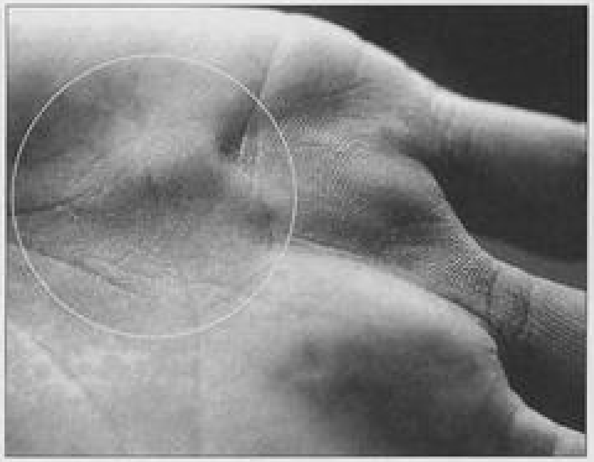
THERAPY

Therapy of the "Trigger Finger"

- Stress reduction
- Non steroid antiphlogistic drugs
- Cortisone injection into the tendon sheath
- Surgical therapy with splitting of the A1-pulley

3.3 Dupuytren's Contracture

Dupuytren's contracture is a nodulous soft tissue scar of the fascia in the palm of the hand. This scarring can grow large enough to surround the flexor tendons and then reduce their range of motion. Its chief symptom is an inability to completely extend the fingers. Historically, this is a disease that occurs in people between the age of 40 and 60, and is caused by genetic predisposition, many chronic micro-traumas associated with hard labor, or alcoholism.
However, it is on the rise in climbers, probably because of the constant stress the tendons are put under when climbing



The early stage of dupuytren's contracture in an 18-year-old climber

(or alcoholism among Alpinists!). This condition is so rare among younger people that a number of young climbers who suffered from it have actually been misdiagnosed with a malignant tumor. Never the less, there is no scientific proof that climbing can bring about dupuytren's contracture, though repetitive scaring of the tendons can lead to the same type of scar tissue.
This scar tissue of the fascia is usually found around the flexor tendons of the ring and small fingers and is sensitive to pressure. Initially a knot in the palm, and a fair bit of pain, are the only symptoms, but eventually there will be a slight contraction of the tendon and the fingers will be held in a permanent semi-flexed position. Extending them might still be possible, but extending them completely is not. This condition will worsen until the fingers are permanently flexed, rendering the hand pretty much useless as anything other than a club! If not treated early enough the condition might require the complete amputation of the fingers.

SYMPTOMS

Symptoms of Dupuytren's Contracture

- Nodular soft tissue scars in the palm (mostly ring- or small finger)
- Pressure tenderness
- Fixed flexed position of the finger

The disease can stop in its early stages, though if it does not the above stated scenario of useless fingers will result. In the early stages the therapy is generally just vigorous massage to help release those knots. If the condition continues to worsen surgery will be necessary to remove the scar tissue around the tendon. This surgery is quite difficult and, unfortuna-

tely, the incidence of re-occurrence is high. Stretching helps in prevention
Following surgery for dupuytren's contracture you can expect at least 3 months of time away from climbing.

THERAPY

Therapy of Dupuytren's Contracture

- Massaging, stretching
- Surgical removal of scar tissue

3.4 Ganglion

A ganglion is a liquid-filled area in the joint capsule or tendon sheath that has bulged out to one side. This bulging of the capsule or sheath is generally found in a congenitally weaker area that cannot handle the extra pressure of the over-creation of synovial fluid. Chronic over use and excessive stress create large amounts of synovial fluid, so this condition is not uncommon in climbers.

The most frequent location for a ganglion is in the extensor side of the wrist joint or, especially in climbers, in the flexor tendon sheaths just before the first finger joint.
Depending on the size and location of the ganglion, the symptoms can be pain, visible swelling of a lump, and a decrease in mobility. The size of a ganglion is directly related to the amount of stress the area is under as the more stress there is, the more fluid is created. Often a couple of rest days will reduce the size of the ganglion as the amount of fluid decreases in the tendon sheath and capsule.
If the ganglion becomes a chronic nuisance, it should be surgically removed. Puncturing, squeezing, or crushing it, are old remedies that are not very effective, as the ganglion will simply form again.

SYMPTOMS

Symptoms of Ganglions

- Pain when put under stress
- Pressure tenderness
- Decreased mobility
- A lump under the skin

THERAPY

Therapy for a Ganglion
- Rest
- Surgical removal
- Finger/hand exercices with softball or theraband hand exerciser®
- Ice, rubs

3.5 Myogelosis

The muscles of athletes, especially the forearms and shoulders of climbers, can become excessively tight. A muscle that is too tight does not receive the appropriate amount of blood flow, which in turn, allows the acids that are created during exercise to build up in the muscle body.
This condition, known as myogelosis, reduces cell metabolism in the muscle and does not allow the cells to receive the proper nutrition they require to function correctly. Myogelosis can be painful and inhibit a climber's ability. If the condition is not treated as soon as possible, it can scar the muscle permanently.
Through heating, massaging, and stretching the muscle, the excessive tightness can often be worked out.
To prevent myogelosis from occurring during periods of intense training, it is important that climbers warm up correctly and then go through a "cool down" period (find this in one of the books specifically on training) at the end of each workout needs a period.

SYMPTOMS

Symptoms of Myogelosis

- Palpable knots within the muscle
- Tenderness to pressure
- Muscle tightness

THERAPY

Therapy of Myogelosis

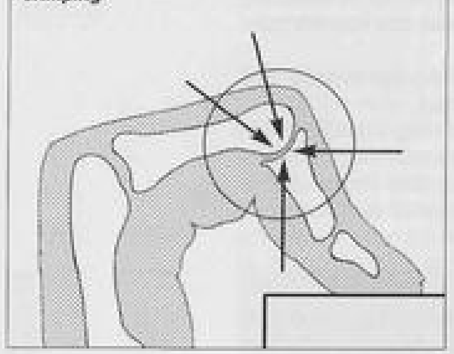
- Heat therapy
- Massage
- Stretching

3.6 Swelling of the Finger Joints

Roughly forty percent of all rock climbers have what might be described by non-climbers as excessively thick fingers. Even climbers who have only been active in the sport for a short time can have larger than normal joints. Often this is an adaptation to the stress climbing puts on the collateral ligament and joint capsule, but it can also be a symptom of an overuse syndrome.

As stated before, overuse syndromes in the fingers can usually be attributed to doing a lot of climbing on small holds and in the crimping position. When crimping the middle finger joint is flexed almost to its maximum and the end-joints are over-extended. In most exercises pressure is spread out over all of the cartilage surface, but in climbing the continuous holding of the crimping position forces one specific spot in the cartilage to take all of the pressure.

Cartilage stress through crimping



Over time this compresses the cartilage and reduces its ability to work as a shock absorber. Micro-tears often form in the cartilage, which lead to the output of enzymes that irritate the synovial tissue. This then leads to an increase in synovial fluid, which then starts a vicious circle; increased synovial fluid puts pressure on synovial tissue, which increases the synovial fluid...

Excessive and potentially damaging stress is placed on small sections of cartilage when the fingers are in the crimping position.

This chronic increase in synovial fluid can be visible as swelling of the finger joints. The range of motion in the fingers, that is their ability to fully flex or extend, is reduced by the increase in synovial fluid. The morning following an intense day of climbing or training is often when the condition is the most noticeable as the lack of motion while sleeping has allowed the fluid to build up.

Chronic increases in the synovial fluid put mild pressure on numerous nerve endings in the joint and this creates a dull ache.

Many climbers suffer from this condition for so long that the pain is not noticeable. Whether this is simply due to the fact that they become conditioned to the pain or whether, over time, they actually damage the nerve endings, is not known.

This is the hand of a climber who has been on the cutting edge of the sport for 25 years. Doctors find it surprising that high-level climbers don't complain about the pain associated with the swelling of the finger joints. It's not clear whether this ability to deal with pain is due to damage to the nerve endings in the joint capsule or an increase in pain tolerance.

People who climb year-round often exhibit chronic instabilities in their finger joints. The lateral stress of the fingers, for instance in a finger crack, can cause micro-trauma of the collateral ligaments. When this is combined with the increase in synovial fluid (as described above), there can be an even higher level of instability in the joint.

Causes of Chronic Swelling of the Finger Joints

- Increased synovia
- Thickening of the joint capsule
- Cartilage damage
- Hypertrophy of the collateral ligaments
- Osteophytes (bone spurs)

CAUSES

SYMPTOMS

Symptoms of Chronic Finger Joint Swellings

- Early morning finger stiffness
- Pain after stress
- Decreases in mobility and fine co-ordination

It should not be forgotten that the chronic thickening of the finger joints could be from osseous reactions associated with osteoarthritis and osteophytes (bone spurs). Without seeing a physician you cannot be sure you are not suffering from one of the above conditions. Even if you are diagnosed with one of these conditions, it is not certain that the osteoarthritis and bone spurs weren't brought on by the excessive stress of climbing!

As in all overuse syndromes, chronic swelling of the fingers requires an immediate break from the stresses that are causing the swelling (i.e. climbing). To prevent the swelling from coming on in the first place you should adopt some stretches and warm up routines that will specifically prepare your hands for climbing. A good warm up should increase blood flow through the joint and help the cartilage to recover. With many chronic problems the application of heat helps to relieve the symptoms, but acute overuse could require ice to reduce the swelling. Either therapy might work, and you should talk to a doctor or a physical therapist to come up with the proper plan for you.

THERAPY

Therapy for Chronic Finger Swellings

- Stress reduction
- In the acute phases: cold, ice
- In a chronic state: heat
- Movement without stress (softball, therapy puddy, Qi-Gong balls, hand exerciser)
- Slight pulling on the joints over 30 - 40 seconds
- Sulphur baths

3.7 Arthritis of the Finger Joints

As sports-medicine doctors we are frequently faced with the question of whether climbers are more susceptible to arthritis in the fingers than non-climbers. The answer to that question is very complex as arthritis develops for different reasons and based on different factors, many of which are based on the individual's genetics.

First off, lets clarify the term as it is commonly used. Arthritis, or osteoarthritis, can be simply defined as inflammation of the joint caused by damage to the cartilage and bone. Osteoarthritis is generally caused by long-term overuse and excessive stress, so the cartilage, the surface-area that takes most of the stress in the joint, usually suffers more than the bone.

In each joint there is a low-friction, superficial surface to the bone, usually between one and six millimeters thick, known as cartilage. Cartilage works as both a friction reducer and a shock absorber. As we stated before, the cartilage is not brought nutrition via its own blood vessels, but instead is fed from the joint fluid, or synovia. We define the cartilage as being not only the cartilage cells but also the substances between the cells. These substances are made up of various glucosaminoglycanes and help the cartilage spread out intense pressure by giving it some elasticity.

Excessive build-up of bone (arrows) in long-term climbers is often visible with x-rays.

Repetitive movement, like typing or squeezing one of the devices that are commonly used for warming up the hands, diffuses the synovial fluid into the joint and thereby gives the cartilage its nutrition. However, intense peaks in pressure, like what happens to your knees when you jump or what happens to your fingers when you crimp an edge, evolve in microfractures of the cartilage and are setting free aggressive enzymes of the cartilage. This enzymes stimulate the joint capsule mucous membrane to increase synovia production – the physiologic equilibrium is harmed and a vicious cycle: stress – efusion – mucous membrane swelling – begins.

In medicine we differentiate between primary and secondary arthritis. The source of primary arthritis has not been determined yet. All we know is that it is a disease that comes about with aging and the slow breakdown of the joint over time.

In secondary arthritis there are trigger factors, for instance the removal of the meniscus in the knee joint or various metabolic diseases. For athletes, one trigger factor is the frequent micro-trauma that various sports require. For example, in weight lifting or skiing, where intense pressure is placed on the joint, small micro tears and points of damage decrease the cartilages elasticity. Even worse than just the pressure peaks, at the end of a joints range of motion the protection of the joint by the tension in the muscles is gone, putting the majority of the pressure on the cartilage surface. A couple classic examples of this would be a basketball player landing on a straight knee, or a climber crimping a very small edge so as to force the last digit of the fingers into a hyper-extended position. You do this last one all the time!

Interestingly, endurance athletes, like long distance runners and cyclists, do not necessarily show any increased wear on the joint. (This is of course provided that their hips and knees are working in anatomically correct positions and making even contact in the joint). Rather than wear out the cartilage, these sports help to bring nutrition to the joint. Endurance sports help to diffuse synovia and tend to lack the pressure peaks of climbing and weight lifting. This actually heals the joint.

To sum all that up, sports with repetitive pressure peaks can, over time, cause osteoarthritis. In the beginning the pain of osteoarthritis is only present when stress is placed on the joint, but as the disease progresses the pain can be prevalent when resting and at night.

This is serious osteoarthritis in a 48-year-old climber. Strangely, despite the near total destruction of the joint, the climber still has most of his mobility and almost no pain.

Now lets go back to the original question: is a climber more prone to arthritis than the average person? We climbers place an enormous amount of stress, as pressure peaks, on the joints of our hands (and elbows, shoulders, and feet). Without doubt chronic finger swelling, which many of us suffer from, is a sign of overuse, and this same symptom is known to damage cartilage in the knee joint. If many of these same symptoms of acute overuse are prevalent in the finger joints, and if the fingers work like the knees, then arthritis will probably be the result. In short, the probable answer is "YES!".

The science of who is at the highest risk of suffering from arthritis is still unclear, but we are beginning to get some ideas. It seems male climbers are more likely to suffer from arthritis than female climbers. Also, climbers who are injured frequently and get no treatment for those injuries (i.e. "I'll just climb through it") are also in a higher risk group.

The good news is that we have seen a lot of X-rays of long-term climbers with no signs of destruction to the joint. A lot of individual factors, meaning factors that relate directly to the individual person, are at work here, and those things could not be taken into account (examples would be genetics or diet). However, it is clear that the risk of osteoarthritis is higher for climbers than non-climbers.

As a prophylactic, you can properly warm up the joints and cool down after a work out. Also, listen to your body, and if you feel the pain of an injury, take time off and see a doctor for treatment.

Causes of Osteoarthritis

- Genetic disposition
- Chronic micro-trauma
- Untreated injuries
- Excessive stress to the joint
- Bad technique when training

CAUSES

PREVENTION

Prevention of Osteoarthritis

- Slowly increased training over the years
- Listening to warning symptoms and performing according to them
- Cooling down after training
- Removal of high risk training methods and crimp positions

THERAPY

Therapy for Osteoarthritis

- Stress reduction
- In the acute state: cold, ice
- In the chronic state: heat
- Movement without stress (soft balls, therapy kit, Qi-Gong-balls)
- Slight pulling on the joint over 30 - 40 seconds
- Sulphur baths
- Kneading of hot sand
- In the acute state, non-steroidal antiinflammatory drugs
- Local intra-articular injection of a crystalloid corticoid

3.8 Functional Compartment Syndrome of the Forearm Flexor Muscles

Stress related pain in the forearms during difficult climbing is a given factor. If the pain is very intense and does not decrease (or actually increases) after a day or two of rest, the climber may be suffering from functional compartment syndrome (a.k.a. chronic excertional compartment syndrome).

The pain is characterized by a feeling that the forearm might be about to pop! In other words, you feel really, really, pumped. An especially strong indicator is if the pumped sensation comes quickly during the work out and at climbing levels way below where your peak has recently been.

Chronic compartment syndrome is an increase in the muscle size without an increase in the volume of the muscle fascia (the membrane that encases all your muscles). When the muscle increases in size it needs to fill space.

Since the fascia does not grow fast enough to accommodate the larger muscle, the muscle presses in on the only empty spaces in its body; the veins and arteries. When you activate the muscle the body tries to send blood into it, but the vascular system the blood would flow through is constricted by the enlarged muscle. The result is a back flow of blood from the arm and an instant pump. The muscle still creates the lactic acid, giving you that "burn" we feel during climbing, but the blood cannot remove it. This pain can continue for days.

Functional compartment syndrome occurs when the muscles grow faster than the fascia through high intensity training (hypertrophy). Highly trained athletes can also experience the syndrome when an infectious disease has compromised their immune system. The diagnosis is difficult and many doctors do not expect to see in the forearms. In order to know for certain that you suffer from this syndrome, an intra-compartmental pressure measurement must be taken while performing the sport specific stress (i.e. climbing).

To do this a small catheter is placed inside the muscle (with local anesthetic) and the pressures are measured during and after climbing. If the pressure reaches a certain point and does not return to normal in a given amount of time, the diagnosis is proven.

Therapy for the syndrome is the stretching of the muscles, massage, ice, and hot and cold showers. Also, non-steroidal antiphlogistic drugs like ibuprofen help to reduce the swelling. If all of these forms of therapy do not help, a surgical procedure where the fascia is split needs to be done.

Compartment syndrome can only be proven by measuring intramuscular pressure while placing the muscle under the normal stress of climbing

SYMPTOMS

Symptoms of Compartment Syndrome

- Pain in the flexor muscles during and after stress
- A sense you are extremely pumped that does not go away in the usual time

THERAPY

Therapy for Compartment Syndrome

- Stress reduction
- Stretching
- Antiphlogistic drugs
- Massages and lymphatic system drainage
- In severe cases a surgical procedure

This is a photo of one of the author's arms, one after having compartment syndrome and then having surgery to correct it, and the other arm never having suffered the condition. Note the bulge in the right arm where the flexor muscles have been released through the fascia.

3.9 Overuse Syndromes of the Elbow

Elbow pain is the Plague to climbers. The most common forms of pain are associated with so-called tennis elbow (lateral epicondylitis) and golfers elbow (medial epicondylitis), but there are other problems that can occur in the elbow. For instance, the other muscles that insert near the elbow joint, like the biceps, the brachialis, and the triceps, can also become inflamed near their attachments to the bone.

We need to remember that the regeneration of tendon tissue is much slower than the regeneration of muscle tissue. The insertion point, where the tendon meets the bone, is where many different levels of elasticity occur in the various tissues, and often these levels of flex are not evenly distributed. This is all complicated by the fact that the muscles of this region are very strong and, when climbing, place demands on a relatively small area (compare the knee to the elbow). A great example of this is the medial epicondyle tendon. It is only a few millimeters in diameter but has to handle most of the force of your fingers!

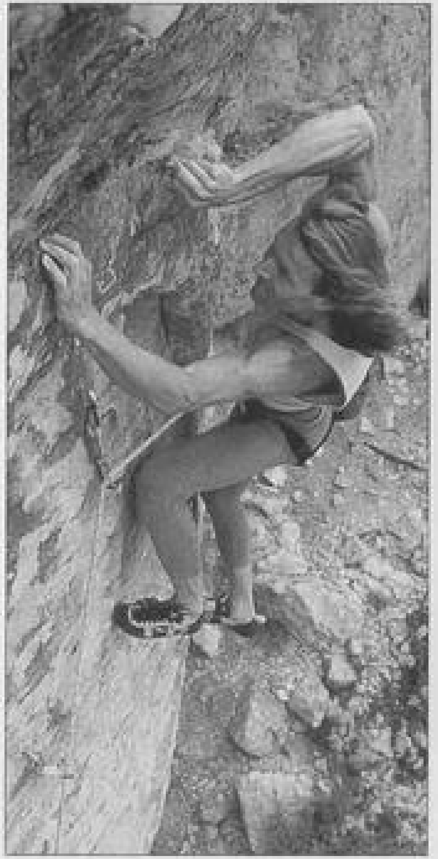
By taking a look at various climbing techniques we can see how the stress is placed on the joint and therefore come up with some ideas of how to alleviate some of the problems:

The sheer number of cases of tendonitis at the lateral epicondyle, the point of origin for the finger extensor muscles, should remind all climbers that the extensors are just as important in climbing as the flexors. As we said before, the flexor muscles can only work efficiently when the extensors have stabilized the wrist joint in a slightly over extended position. Remembering that muscular imbalance often leads to overuse syndromes, one can see how strong flexors will help to create a problem for the insertion point of the extensors.

Locking off low, as is commonly done on difficult climbs and as shown here with the left hand, puts the connections in the elbow joint under extreme stress. (Markus Schweiger on "Piefke" (Fb 7b), Zillertal/Austria)

Elbow problems are also common for crack climbers as the jamming position is very stressful. Thumb down jams are especially stressful for the elbow as the rotational force increases the tension on the already flexing joint.

Almost all patients suffering from tennis elbow (lateral epicondylitis) have a short and less developed extensor group. Initial treatment for mild cases of tennis elbow is stretching and developing the extensors. If the extensors cannot be stretched through therapy then it is unlikely the pain will recede. This is one more piece of proof that stretching and developing both muscle groups is necessary to maintain good health.



Just as there is an imbalance between the flexors and extensors in the elbow, there is also generally an imbalance between the inward and outward rotating muscles, those being the pronators and supinators. For climbing, the bicep pivot point is in the wrong position as climbing forces your grip to be more pronated.
When a climber pulls on a horizontal edge, the pronating muscles, which are smaller and inherently weaker, are forced to work against the supinators. The pronators pull the hand around so that the palm faces the wall and does not simply spin around to a palms-up position and off the edge. This often leads to inflammation of the tendon insertion at the medial epicondyle.

In rare cases, blockages, like bonespurs, of the nerves in your cervical and thoracic vertebrae can show symptoms of elbow pain.

Side-pull moves, or "Gaston's", put a lot of stress on the elbow
(Wolfgang Schweiger on "The Example" (5.13c), Shelf Road/USA)

A few tips:

The first form of therapy for any of these pains is to change your climbing technique. For tennis players suffering tennis elbow, something as insignificant as changing rackets is often enough to alter technique. Perhaps climbing on different terrain for a while, like going from steep, big hold climbing to vertical climbing, will help get rid of epicondylitis. The same may hold true for tendonitis of the brachialis, the so-called climbers elbow, or for the many climbers who suffer from medial epicondylitis (golfers elbow). A change in technique, or a change in form, may help reduce much of the swelling.

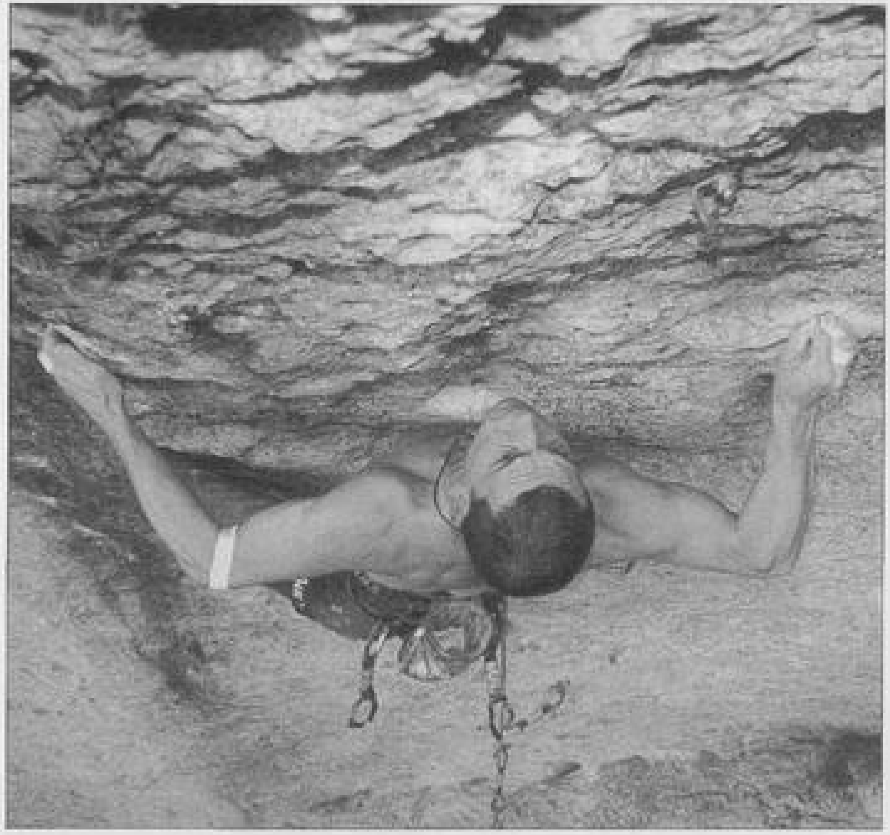
Elbow pain on the dorsal side of the elbow (the back) is usually caused by overuse of the triceps tendon. Doing pull-ups from a dead-hang rather than from a slightly bent arm often brings this about. If you are going to do chin-ups, make sure you do not lower yourself all the way down. Instead, stop the decent with a slight bend in your elbow and then come back up for the next chin-up.

All exercises for the upper arm flexors, the biceps, should be performed with the arm pronated (rotated palm up) so as to reduce the stress put on the supinators.

When training, it is important to change both the size of the holds you use and the distance between those holds. This allows for different angles and positions to be used and therefore to not force the connective tissues to repeat the same stressful move over and over again. Also, the finger extensors and the pronators need to be trained separately as traditional climbing-training does not give them a sufficient workout. Don't forget that there are special warm-ups for these muscles (see Chapter 4).

In overuse syndromes of the elbow and the forearms, climbing and training should be curtailed at least until the pain is no longer present. For proper healing of severe overuse syndromes, a period of rest after the pain has subsided is required. If after this sufficient rest period you do not have a reduction in the symptoms, then special tests to detect the imbalances in the various muscle groups of the arm, shoulder, and back, must be performed.

Surgery should only be considered as a last resort. In general, surgery on functional imbalances in the elbow can create as many problems as it relieves. In our experience therapy, a reduction of training and climbing, and a change in training methods, worked on nearly all tendon overuse syndromes. In most cases the patient was able to return to the sport and reach the same, or even higher, level of difficulty.



When climbing with elbow problems, taping the elbow works well. Though initially taping feels constrictive, it actually only has a minor effect on blood flow.
(Volker Schoeffl on "Das 5. Element" (10–/10), Frankenjura/Germany).

Defining Elbow Pain

Pressure tenderness at:
- Medial epicondylitis = golfer's elbow
- Lateral epicondylitis = tennis elbow
- Ventral joint pain = overuse syndrome of the biceps or the brachialis muscle (climbers elbow)
- Dorsal joint pain = overuse syndrome of the insertion of the triceps tendon

DEFINITIONS

Therapy for Elbow Pain

- Stress reduction
- Non-steroidal anti-inflammatory drugs
- Local injections
- Ice
- Stretching
- Local tape
- Changing of climbing technique and training methods
- External braces
- Acupuncture and acupressure
- After decrease of the acute symptoms, special training for the overuse muscle groups

THERAPY

For prevention,
DO NOT DO ANY OF THE FOLLOWING:

- Use dangerous methods to train (this includes negative eccentric stress such as negative pull ups with additional weights, descending a Bachar-ladder, down jumping and down climbing the campus board)
- Climb when your muscles are exhausted
- Train with uniform monotonous programs such as pull-up pyramids
- Perform feet-free hand over hand traverses

PREVENTION

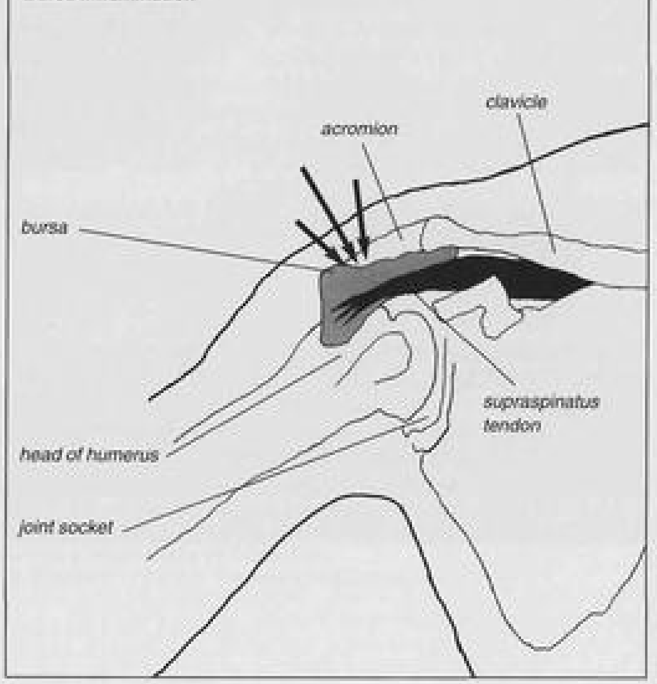
3.10 Overuse Syndromes of the Shoulder

The shoulder joint, being a ball and socket, is primarily stabilized by muscle tension and the joint capsule. Generally, climbers suffer from two problems in the shoulder, both of which stem from the way the joint is stabilized.

3.10.1 Inflammation of the Bursa (bursitis) and Overuse Syndromes of the Rotator Cuff (impingement syndrome)

If the muscles of the back, mainly the rhomboids and trapezius, do not stabilize the scapula then the space between the head of the humerous and the top of the socket (the acromion) is smaller than necessary. This action, known as humorous head elevation, then squeezes the bursa and rotator cuff muscles. The bursa becomes inflamed and the tendons of the rotator cuff, especially the supraspinatus, are subject to minor tearing, inflammation, and calcium buildup.

Bursa inflammation



If the scapula is not stabile the bursa and rotator cuff are squeezed when the arm is raised. (arrows)

Often the biceps and pectoralis muscles are excessively tight in climbers which brings about an inward rotation of the shoulder. To remedy this, these muscles should be regularly stretched (see the Stretching chapter). In addition, the stabilizing muscles, like the rhomboids and trapezius, should be trained.
This is a long-term process, but the shoulder usually reacts well to development of these muscles.
This, as well as some specific exercises for the rotator cuff muscles, will reduce humorous head elevation.

CAUSES

Causes of Bursa Inflammation and Overuse Syndromes to the Rotator Cuff

- Relative weakness of the scapula stabilizing muscles
- Relative weakness of the rotator cuff muscles
- Tight biceps
- Poor technique

SYMPTOMS

Symptoms of Bursa Inflammation and Overuse Syndromes of the Rotator Cuff

- Pain when elevating the arm against pressure
- Shoulder pain when moving the arm overhead

THERAPY

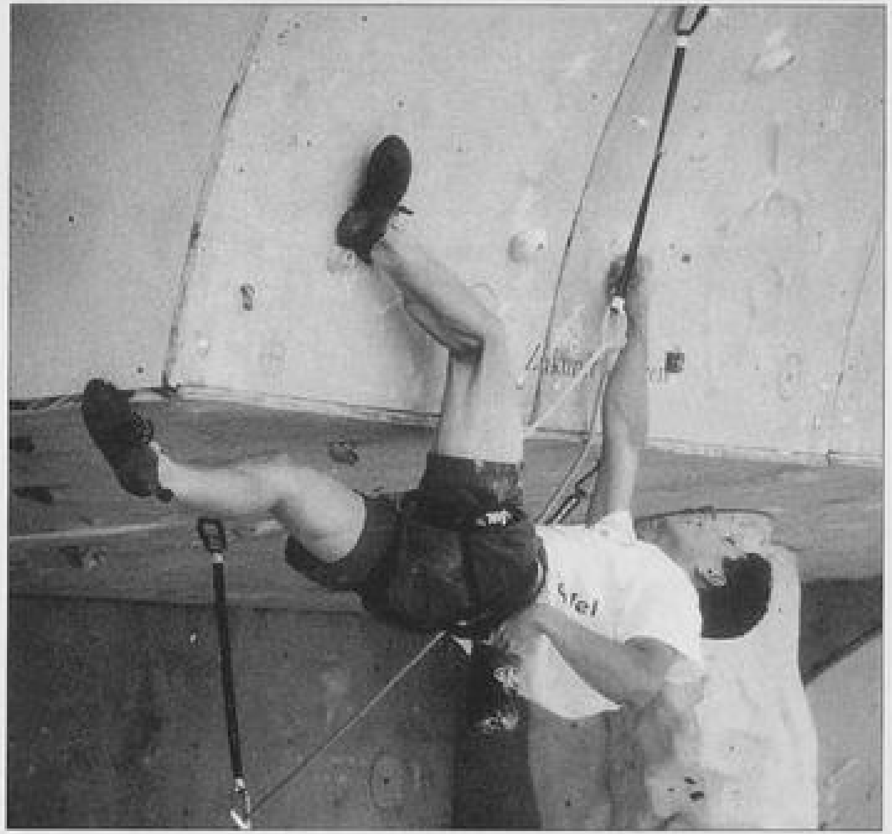
Therapy of Bursa Inflammation and Overuse Syndromes of the Rotator Cuff

- Special training of the muscles stabilizing the scapula and the rotator cuff
- Stretching of the biceps
- Stretching of the triceps
- Stretching of the pectoralis
- A change in technique
- Physiotherapy
- Anti-inflammatory injections
- In rare cases surgery

3.10.2 Instability of the Shoulder

In the last few years there has been an increase in the number of climbers with instability in the shoulder joint, especially in older climbers, competition climbers, and climbers who predominately climb on very steep rock. Climbers who like to rest by hanging from a completely extended arm are especially vulnerable to shoulder instability. When a climber is resting on a completely relaxed shoulder, all of his/her weight is held by the connective tissues of the joint capsule. These passive structures are not meant to work without the flexing of the surrounding muscles. Over time, the constant stress tends to stretch them and thus loosen shoulder joint. This can be remedied simply by maintaining some tension in the muscles of the shoulder when hanging from your hands.

Frequent passive hanging on straight arms can lead to instabilities in the shoulder.



Diagnosing a shoulder as "loose", or instable, can be very difficult as each individual's ligament-tension varies greatly. One athlete can function well with a lot movement in the shoulder, while another cannot perform his/her sport with even a small amount of instability.

Relative weakness in the forearms can also cause instability as the climber, when pumped, will increase the angle in the elbows to increase the mechanical advantage. This positioning of the arms, commonly known as the "Chicken Wing", pulls the shoulder to a less stabile and more strained position. Here again, stress is put on the connective tissue that can lead to a stretching and loosening of the joint attachments.

Causes of Instabilities

- Generally loose ligaments
- Frequent passive hanging on the shoulder (straight arm position).

CAUSES

Symptoms of Instabilities

- Snapping phenomena
- Pain while moving and stressing the joint

SYMPTOMS

Therapy for Instability

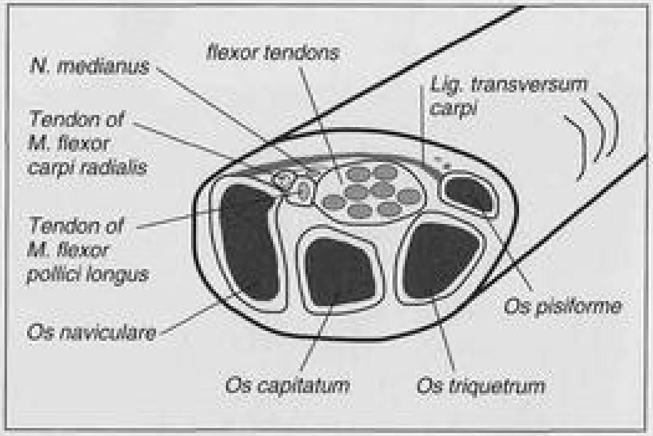
- Muscle training of the rotator cuff
- Muscle training of the scapula-stabilizing muscles
- Surgical procedures in rare cases

THERAPY

3.11 Nerve Compression Syndromes

Nerve compression syndromes are defined by the constriction, and often the altering of the position, of a nerve, usually because of the development of excessive scar tissue. Nerve compression syndromes are seen more often by doctors specializing in rheumatoid arthritis than they are by sports-medicine doctors. However, in some sports the effects of repetitive micro-trauma and stress can create functional problems for the nerves. Just as repetitive micro-trauma and stress bring on the pain, the reduction of the pain happens with a reduction in those stresses and micro-traumas. This means that some nerve compression syndromes are actually approached as overuse syndromes because their existence stems from overuse. Sometimes the constriction becomes so bad that the only way to give an athlete relief is to surgically repair the problem.

3.11.1 Carpaltunnel Syndrome (CTS)



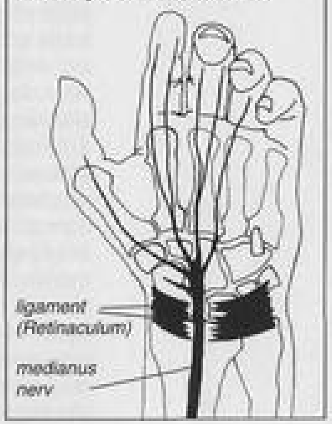
This is the cross section of the carpal-tunnel in the wrist with the palm facing up. The bones of the wrist are laid out in an arch with the transverse ligament running over the top and creating the roof of the tunnel". The flexor tendons run alongside medianus nerve inside the so-called "carpal tunnel".

A few definitions of the types of nerve impulses will help you to understand the effects of nerve compression syndromes. Motor transmission is the transfer of information from the brain to the muscles so that they can perform a given action. Sensitivity transmission is the sending of information on temperature, pain, and pressure, as well as something known as proprioceptive-sensitivity, from the limbs to the brain.

Proprioceptive sensitivity is generally transferred from inside the joint capsule and tells the brain what the positioning of that joint is.

There are three large nerves, the radius, medianus, and ulnaris, that handle most of this transmission through your arm, all of them branching out from the upper vertebral spine. The medianus nerve runs between the radial and ulnar nerve and is responsible for transferring motor information from the thumb, index fingers, and half of the middle and ring fingers. It is also responsible for the sensitivity of these digits. The medianus runs down the arm and through the flexor side of the wrist and through the carpal tunnel.

Anatomy of medianus nerve



The medianus nerve transfers sensitivity information for the thumb, index, middle and ring finger.

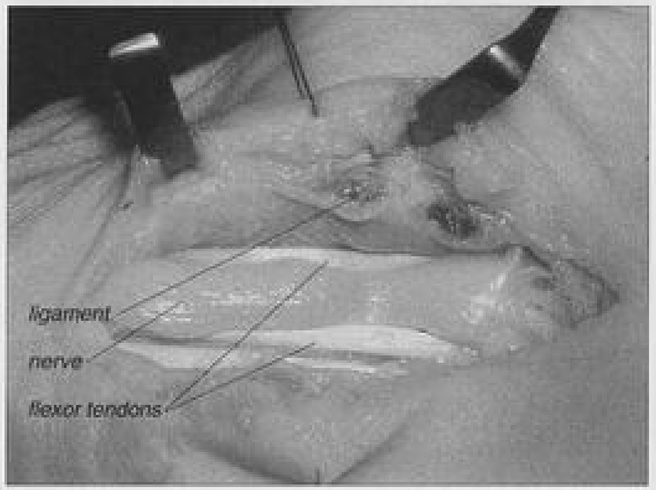
Also running through this tunnel are the flexor tendons, which you can easily feel with your fingers when over flexing your wrist. If the tendons become inflamed, or if they grow as a reaction to heavy usage, they will occupy more space than the tunnel provides. Rather than push out the ligament, which is very tight and does not flex much, the tendons will press on the medianus nerve. If this increase in pressure continues for a long time, not only will the sensitivity transmission of the medianus nerve be impeded, but also the motor transmission. This is a painful condition that will inhibit your ability to use your thumb and much of the hand. It is commonly known as carpal tunnel syndrome, or CTS. This syndrome is common in athletes, from rowers to cyclists, who place a lot of pressure on their hands. Climbers can obviously be enormously affected by it.

Important

A long-term reduction in the sensitivity of the fingers needs to be properly diagnosed by a physician.
If the pressure on the nerve continues for a long time a functional deficit in motor response may result.
In other words, you may lose some of the ability to work with the hand.
If this is allowed to continue long-term, full use of the fingers and thumb may not be recoverable!

The first signs of CTS usually occur during the night. As all of your physiologic systems are working at a reduced level while you sleep, there is a decrease in blood flow to the region, which can often reduce the flow of nutrients to the nerve. Also, many people sleep in the "fetal position", on their side with their knees drawn up and hand curled under the chin. This curled position of the hand is an over-flexing of the wrist that can exacerbate the syndrome by constricting the arteries feeding the hand and increasing the pressure on the medianus nerve. The results are often a general numbness, tingling, and pain in the first three long fingers and the thumb. These are the classic symptoms of CTS.

Sport climbers tend to see such large increases in the muscle mass of their forearms that the muscles themselves may outgrow the space of the carpal tunnel. In most people the finger flexor muscles begin to separate from the tendons mid-way up the forearm, but through M.R.I exams we have seen sport climbers whose muscle bodies are so long that they extend down into the carpal tunnel. This extended muscle body, which is not clearly understood by science, obviously will reduce the space allocated to the medianus nerve in the tunnel. Medical science is trying to decide if the climbers tested had developed these extended muscles through training or if they were born with a propensity for this condition. At the time of this edition we don't know the answer.



This is a shot of the carpal tunnel during an operation to repair CTS. The transverse ligament has already been split leaving the nerve and flexor tendons exposed underneath. You can see that the nerve is thinner where it has been constricted by the ligament. This constriction no doubt put serious pressure on the nerve and impeded its function. On the right side of the incision you can see where the medianus nerve splits into branches that run into the fingers.

3.11.2 Supinator Syndrome

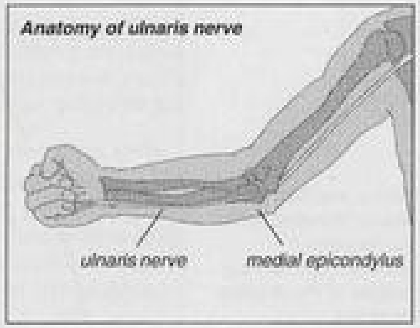
Though rare, the so-called supinator syndrome can cause elbow problems. The supinator muscle, which turns the hand in an outward rotation (remember "cupping soup"), runs through the upper third of the forearm. This muscle gets a lot of work from climbers when under-clinging, doing certain types of pull-ups, or opening wine bottles! One branch of the radialis nerve runs through this muscle. If the supinator swells excessively from overuse it can constrict the nerve. The constriction causes motor responses to flow back up the nerve, which is often interpreted by the brain as pain in the elbow. If the stress on the muscle continues, this condition can be made permanent by a buildup of scar tissue around the nerve. Conservative therapy (mostly stretching) is often effective at relieving the stress from the supinator. However, if the conservative approach does not work, the only recourse to be pain-free is to surgically split the point in the muscle where the nerve is constricted.

3.11.3 Sulcus Ulnaris Syndrome

Sulcus ulnaris syndrome manifests itself as a painful electric sensation running down the arm. When you hit your "funny bone", which we all know is about the worst shock in the world, you get the same sensation that this syndrome causes. When you have it, you will know it! That pain is a sudden shock or pressure placed on the ulnaris nerve, and in ulnaris syndrome the pain is caused by a building up of scar tissue around the nerve in the elbow.

This condition can also be brought on by certain exercises, like pull-ups from a dead hang. Straight-armed pull-ups can stretch the ligament that holds the nerve in place, making it possible for the nerve to jump out of position when the arm is flexed. In rare cases, over developed triceps can squeeze the nerve out of its channel.

Anatomy of ulnaris nerve



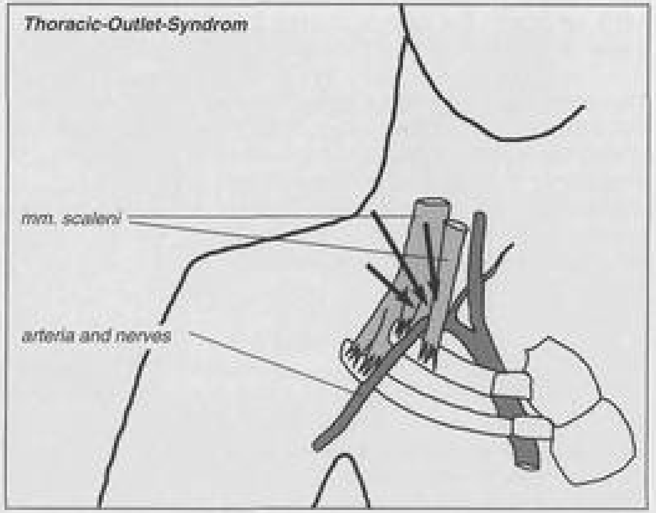
The ulnaris nerve runs through the elbow in its own channel. Scar tissue in the channel can compress the nerve.

Avoiding extreme extension when flexing the elbow, as well taping it (see the Taping Chapter), can remedy this condition. In the early stages the condition can occasionally be fixed by putting an immobilizing cast on the elbow for a couple of weeks. If none of this works, the only alternative is a surgical procedure that secures the nerve in a slightly different channel in the elbow.

3.11.4 Thoracic Outlet Syndrome

Though rare, thoracic outlet syndrome is a nerve compression that affects the shoulder and arm. Over development and tightening of the small chest muscles and the scaleni muscles (in the neck) can put pressure on the nerves and blood vessels running into the arm. People with an extra rib in their upper body can also suffer from this syndrome. The symptoms are diffused pain in the arms, numbness, or a heavy sensation of the hands and lower arms. The condition is most noticeable when the arms are raised above the head. The symptoms vary according to whether the muscles are placing pressure on the nerves or the blood vessels.

Intensive physiotherapy, like stretching the pectoralis and scalene muscles and stretching the thoracic spine, can often reduce the pain. Only in very severe cases is surgery necessary.



Nerve and blood vessel bundles can be squeezed between the various bodies of the scalene muscles.

CAUSES

Causes of Nerve Compression Syndromes

- Swelling of muscles or tendons after stress
- Overstretching in extreme hand positions
- Scar tissue building up through chronic micro trauma
- Anatomic abnormality (long muscle bodies)
- Pressure damage
- Excessively tight muscles
- Reduced flexibility of the nerve

SYMPTOMS

Symptoms of Nerve Compression Syndromes

- Tingling sensation in the fingers (CTS, Sulcus N.ulnaris)
- Numbness and pain at night
- Pain in the elbow joint (supinator syndrome)
- Electric sensation in the fingers
- Muscle atrophy (rare)

3.11.5. Therapy for Nerve Compression Syndromes

The first step in therapy for nerve compression syndromes is to reduce the stress on the nerve. This can be done by stopping the activity causing the stress, taking anti-inflammatory drugs, immobilizing the joint, and seeking physical therapy.

By stopping the activity that causes the problems you will, at the very least, keep it from getting worse. Also, by not using the muscles in the forearm there will be a reduction in the natural swelling that goes on during exercise.

Stretching is very important in CTS as most climbers suffering from the condition have very tight forearm flexor muscles. The excessively tight muscles not only put pressure on the nerve and tendons, but also reduce the nerves ability to adjust its position in the surrounding muscle.

A splint may be necessary to reduce the swelling in the area (commonly used at night as we tend to bend our wrists while we sleep), and anti-inflammatory drugs could help reduce pressure on the nerve. Vitamins B12 and B6 are known to help in the nutrition of damaged nerves and can help in this situation.

To learn the severity of the condition, it may be necessary to take an electronic measurement of the nerves abilities. If none of the above therapies work, this test may tell whether surgery is necessary.

For CTS a single injection of anesthetic, in combination with cortisone, into the carpal tunnel can be effective. Perhaps more effective in the long-term is changing the training and climbing techniques that brought the condition on in the first place. Exercise and training with the hand in different positions, as well as a reduction in the intensity of the climbing or training, will be helpful.

A Few Notes on Cortisone and its Application
Cortisone is a commonly used weapon against inflammation. Without a doubt, cortisone was overused in the past, and its adverse side affects were not well understood. However, the drug is the best anti-inflammatory we have and some overuse syndromes, like tendovaginitis in the fingers, can at times only be remedied through its use. The drug is administered either orally, in tablet form, or as a local injection
.

There are some guidelines that must be obeyed when cortisone is used:

– Cortisone should never be injected directly into the tendon. Injections should go into the tendon sheath or the insertion of the tendon to the bone. Injections directly into the tendon will decrease its elasticity, causing more tearing and potentially a complete tear (this is often seen in the Achilles and the quadricep).

– Injections should go to the same spot in no more than three short intervals.

– The patient should be well versed in the effects of the drug. This is especially important if the patient is seeing multiple doctors for the condition, as each doctor needs to be made aware of what has transpired.

Cortisone therapy often gives immediate relief from the pain. This often leads the patient to believe that he/she has healed from the overuse syndrome that caused it. This is not the case. A rest period, allowing the now less-inflamed tendon to heal, is an absolute must. You must take time off after cortisone therapy in order for it to work.

Special Note for Competition Climbers!

Cortisone, when taken orally, is a violation of the guidelines the use of steroids that were laid out by the International Olympic Committee in 1996. Until recently, local intra-articular injections of cortisone needed to be announced to the anti-doping commission as well.
This is no longer the case, but the rule could change at any time. It is essential that any sports medicine doctor be aware of these guidelines when working with an international competition athlete.

Somewhere between the effectiveness of cortisone and aspirin lay the non-steroidal anti-inflammatory drugs like ibuprofen, diclofenac, and the new-generation COX2-blockers like Vioxx® and Celebrex®. These drugs are known to reduce inflammation and swelling, though some are associated with stomach problems (ibuprofen and similar drugs should be taken with food to help protect the stomach). Vioxx® and Celebrex® are specifically designed so as not to irritate the stomach, though some patients find they are less effective than the older drugs (the effectiveness of the various drugs tends to vary from person to person). If administered right after an injury, the anti-inflammatory effects will often be more pronounced and the healing time therefore reduced. However, excessive use of these drugs, as is common with climbers to curtail finger pain, should be avoided as they do have adverse side effects.

There are naturally occurring anti-inflammatory enzymes, like papain, bromelain, rutosid, and chymotrypsin, which are derived from fruit. These enzymes are 100% natural and, as far as we know, safe to use. However, they do have a down side: they are expensive and in order to be effective must be taken in large doses. Depending on the size of the tablet, you might find yourself ingesting the medicine all day long. If you don't like pills, you could eat 10 pineapples a day and get all the same enzymes, but you will spend most of your day in the bathroom!

THERAPY

Therapy of Nerve Compression Syndromes

- Stress reduction
- Ice
- Anti-inflammatory medication
- Change in training and climbing technique
- Stretching
- Surgical procedures

3.12 The Spine

For the general population, spinal problems like ischialgia and lumbago are the most common physical problem. Back problems are associated with roughly 20% of work-loss and make up half of the reasons people cite when having to retire early. In our survey, nearly 70% of all climbers stated they had suffered back pain at some point in their climbing career.

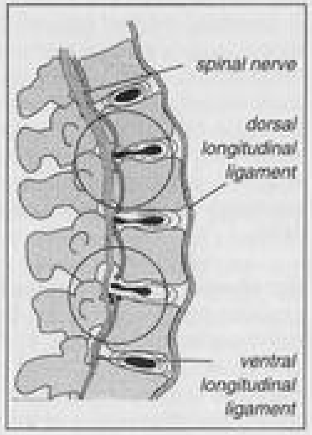
There is a tendency, especially in sport climbers who often climb in uniform manner, to have tight chest and abdominal muscles and relatively weak spine stabilising muscles (*Mm. erector spinae*). This imbalance in muscle development is known to contribute to spinal problems.

What is not known is how much damage is caused to the spine by the repetitive falls sport climber take. It seems possible that the chronic micro-trauma these falls create for the intervertebral discs could lead to early degeneration. However, this would be hard to prove, and so far most climbers who suffer from nucleus pulposus prolapse (a herniated disc) do not report it happening in a fall but instead when doing some sort of twisting motion.

Back pain can be caused by many different problems. Some are minor, and some can be catastrophic. A thorough exam by a physician, and a correct diagnosis, is the first step to an effective recovery.

Myogelosis, or "muscle tension", is the most common cause of back pain. Often through misuse or overuse of the back, the muscles become strained, which can then set up a vicious circle. The muscles seize up from overuse, then due to the stress of being flexed, receive poor blood flow. Lacking

good nutrition, the muscle has to work a bit harder for any motion, increasing the tension and decreasing the blood flow. This condition is especially common in the neck and shoulder area. Until the muscles relax and get blood flow, and therefore get a chance to recover, they will be stiff.



If the intervertebral disc is put under pressure it can herniate (upper circle) out of its fibrous ring and then place pressure on the nerve running out of the spine (lower circle).

Lumbago is a catchall name that refers to any painful reduction in the mobility of the lumbar vertebrae, or lower spine. Ninety-five percent of all cases of lumbago are caused by pressure on the intravertebral spaces in the sacroiliac joint, though it is possible, especially if you feel pain down your legs, that the problem is a herniated disc.

A herniated disc, or nucleus pulposus prolapsus, is more common in the lower back than in the mid back or the neck. Between each vertebra there are shock absorbers that allow the spine to move but stay connected. These shock absorbers, the discs, are made up of a nucleus of thick liquid surrounded by an annular fibrous ring. Nucleus pulposus prolapsus occurs when pressure on the disc creates a bulge in the fibrous ring. This bulge can then put pressure on the nerve that branches out of the spine, and in doing so cause pain, numbness, and a drop motor skills. If there is numbness in the legs and toes, or if motor response is not what it has been in the past, this might be the problem. It is important that you see a doctor if you are exhibiting these symptoms.

Its important to remember that a herniated disc, though commonly talked about, is actually quite rare. If you were to take 100 people suffering back pain into an orthopedic clinic, you would find that less than five of them actually were suffering from a herniated disc. On top of that, herniated discs do not always inhibit your lifestyle and it is not uncommon for doctors to see them on an MRI in a patient who has come complaining of another problem.

There is a rare condition known as spondylolisthesis, or "sli-

ding vertebra", that is generally a function of a birth defect but can be brought on from athletics. Spondylolisthesis occurs when one of the vertebra is actually split (the birth defect) and through intense pulling with a rotation of the torso, as in throwing a football or climbing a very steep wall, the two pieces separate. Again, the condition is very rare.
A blocking of any one of the nerves extending from the spine, by any one of many possible obstructions (slight joint dislocation, tumor, bone spur, cyst, etc.), can cause back pain, as can the over stretching or straining of the ligaments between the vertebra. In short, back pain can be caused by something simple and short lived or it can be caused by something very serious. The only way to know is through a thorough exam by a physician complete with X-rays and an MRI.

For climbers, stress on the back often comes from the very position climbing puts the body in. When climbing, the ventral muscles of the body, in this case the abdominal muscles, are flexed more often and more powerfully than the dorsal muscles (the spinal erector muscles). This leads to a tightening and shortening of the ventral/abdominal muscles. Meanwhile, the back muscles, and by the back muscles we mean the erector muscles of the spine and not the huge latisimus dorsi climbers often develop, are being neglected and are therefore relatively weaker than their dorsal counterparts. When you climb you look up, which causes an over flexing of the spine and therefore a flexing of the erector muscles. In order to flex against the over developed abdominal muscles the erectors have to be put under serious strain. This straining itself can be the source of back pain.

Typical climber posture: overextension of the vertebral spine and a concave chest.

Cervical syndrome, like the term lumbago, is a catchall word for trouble in the neck. Many of the problems in the neck are also brought on by a difference in muscle tension from the dorsal and ventral sides of the body. Climbing with an overextended spine puts a lot of stress on the vertebra of the neck, as does the constant looking-up associated with belaying (if you pay attention!). This can often lead to overdevelopment of the neck muscles and can put stress on the joints in the neck. Stretching, developing the weaker side, or stopping the action that causes the stress, are the only ways one can reduce these problems.

Despite all the training and stretching associated with climbing, the most common reason for back pain is bad posture during day-to-day activities. A difference in the length of your legs (a trait most people unknowingly have), and congenital problems (like scoliosis), can contribute to bad posture.
Though climbing can play a role in back problems, it can also stretch and work the spine, thus actually helping climbers to have a healthier spine than much of the general population. As a matter of fact, climbing is beginning to be used in physiotherapy as a way of alleviating some kinds of back pain. Allowing the lower body to hang and twist, as we often do when climbing, can be good therapy for certain problems. Also, just as climbers tend to suffer back pain because of over developed abdominal muscles, much of the generally population suffers back pain from underdeveloped abdominal muscles. You need an even balance between the muscles in your back and your abdomen to stand erect, so spending a day out climbing is not always bad for us!

Causes of Back Pain

- Imbalance of the abdominal and back muscles
- Tight muscles
- Bad posture

CAUSES

Hidden Symptoms of Back Pain

- Pain that runs into the hip or the leg
- Reduced mobility
- Sensitivity or motor deficit (rare)

SYMPTOMS

Therapy for Back Pain

- Stretching of the M. pectoralis
- Stretching of the M. iliopsoas
- Strengthening of back and abdominal muscles
- Physiotherapy

THERAPY

3.13. Overuse syndroms of the feet

Up until about 40 years ago, most alpine climbing and rock climbing was done in heavy mountain boots. An extra pair of socks was often worn, and the foot was held in a leather cast that protected it but also took away any sensitivity and the need for strength in the toes. Leather boots were replaced by the legendary E.B. in the 70's, and a new generation of rock shoes with sticky rubber was just around the corner. Shoes today have become specialized into the type of rock climbing one wants to do. Attributes like downturn, the concave shape that places pressure on the toes, and asymmetry, concentrating the pressure on the big toe, were unheard of just 15 years ago and have helped to push the grades of difficulty to where they are now.

Through all of the shoe development of the last 40 years one attribute has stayed the same: if you want to get optimal pressure on a given bit of rock, you must have a tight fit. What was once done with the extra pair of socks in an un-flexing boot is now done by pressing the feet into the tightest shoe possible. This approach to climbing-footwear is causing overuse syndromes in our feet.

In our survey of 30 top-level climbers, we found that nearly 90% were willing to put up with pain in their feet if it would improve performance. In many cases, the climbers were wearing shoes that were two to three sizes smaller than their normal shoe size. All of the climbers had calloused pressure marks, a symptom of severe stress, on their feet (take a look back at the section on osteoarthritis!). The constant pressure on the toes was often bruising the tissue under the nails, possibly causing loss of the toenail and an increase in the susceptibility to infection in the future. This breakdown in hygiene of the foot creates an interesting environment for bacteria that could itself become the source of problems.

Hematoma under the nails

NOTE

How to avoid chronical feet problems

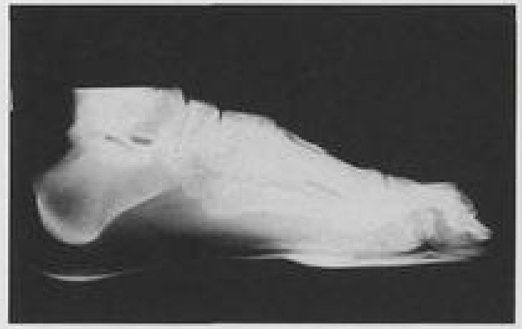
- Reasonable shoe size
- Extra, larger training shoe
- Improved hygienie
- Improvements on the shoe

The picture is a comparison in foot size of a climber with and without his shoes.

3.13.1. Hallux valgus

One problem associated with the chronic use of tight climbing shoes is the development of the hallux valgus deformity. This condition is characterized by the big toe pointing more towards the little toe than it otherwise would. Over time, this could lead to callousing, infections, pain and perhaps osteoarthritis. A tight fitting climbing shoe pushes the toe into the hallux valgus position (as do other tight shoes like high-heels and ballet slippers). In our survey we found 35% of climbers suffered from the hallux valgus deformity, while less than 5% of the general population suffered from the same condition. Unfortunatley conservative therapies do not help with the pain associated with the syndrome, so surgery seems to be the only way to become pain-free.

Hallux valgus in a male climber



X-Ray within climbing shoes

left: visible hallux valgus position, caused by the tight shoe

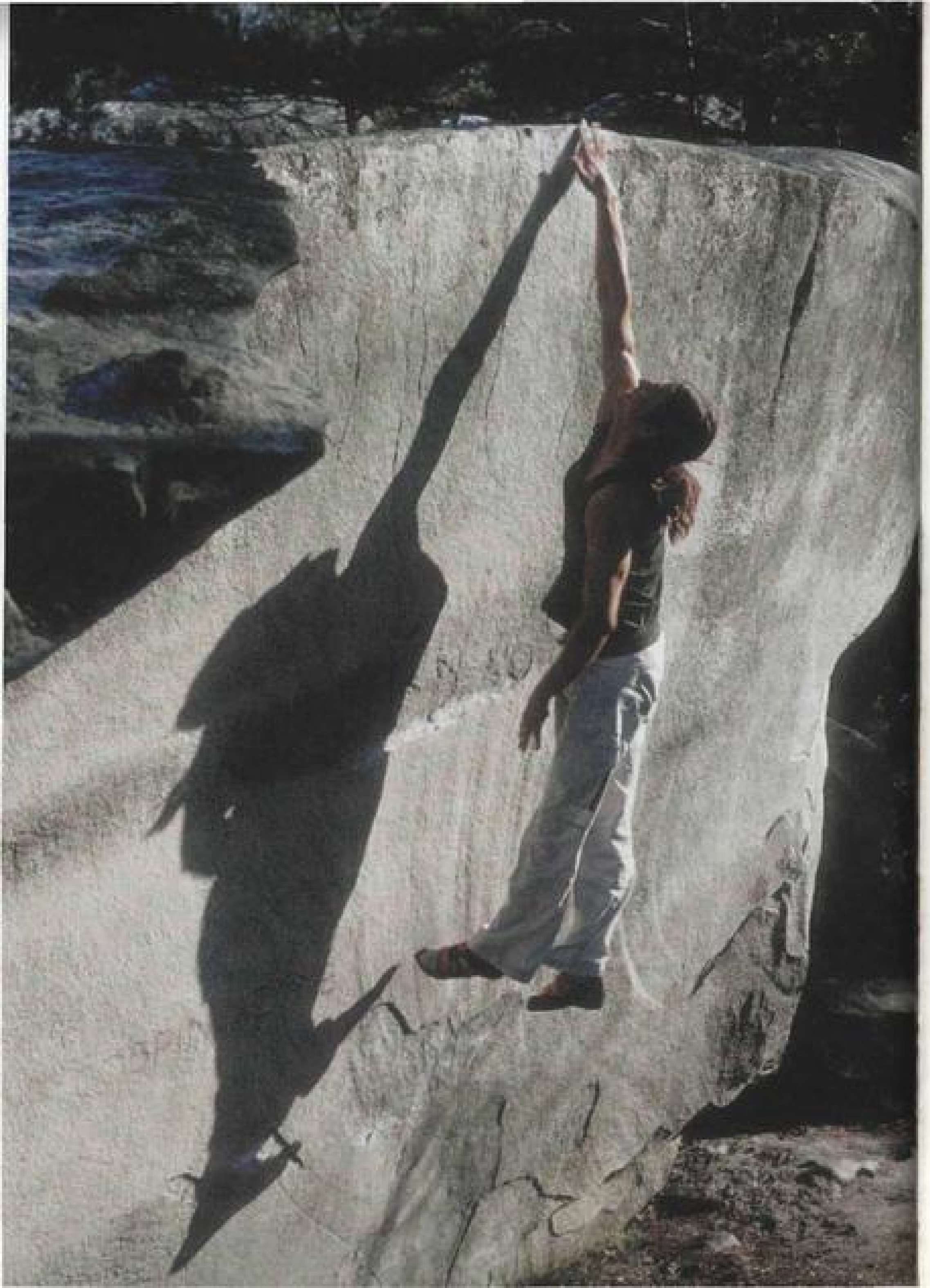
right: notice the curled in toes

3.13.2. Hallux rigidus

Hallux rigidus is the painful developement of osteoarthritis in the first joint of the big toe. It can be brought on from intense pressure, which climbing in tight shoes creates, and besides being painful can also cause a reduction in the toe's mobility. We have seen young climbers, with only a few years of climbing experience, already suffering from this conditon to such a degree that they required surgery. This particular surgery is done by removing a piece of bone from the toe and thus shortening its length. It is not known whether climbing, where intense pressure is again placed on the toe, is advisable.

3.13.3. Hammertoes

Hammer toes are characterized by mis-aligning the middle joints of the toes. Callousing associated with the mis-alignement of the toes can break open and be a base for infections. Also, the constant curling of the toes can lead to a tightening of the extensor tendons. Stretching seems to help in alleviating the deformity.



4. Medical Aspects of Training

The recent increases in levels of difficulty that the sport of rock climbing has experienced have intensified the impacts of the sport on the muscular-skeletal system. Meanwhile, the average age of the top athletes, especially in competition climbing, has steadily gone down. In 1986 the average competitive member of the German National Climbing Team spent about 10 hours a week training and was 26 years old. By 1996 the competitive climber was spending 21 hours a week training and his/her age had dropped to 22 years. Most of this training was good for climbing skills, but some of the exercises might have actually contributed to an increase in injuries. Times have changed, and now we find that thirty percent of all injuries occur during training, and not while climbing.

In the last few years there has been a steady development in training methods for climbers. The growing number of artificial climbing structures and bouldering walls has made it easier to create a complex and specific workout. Today's literature has already greatly improved over the concepts avid trainers like Todd Skinner and Wolfgang Guellich used a dozen years ago. This book does not offer specific training routines so we have noted a few books we can recommend for developing climbing-specific strength. The books listed below explain different training methods that combine strength exercises and endurance workouts with specific climbing motions.

Dale Goddard and Udo Neumann, *Performance Rock Climbing*, Stackpole Books, 1993
Eric Horst, *Training for Climbing, The Definitive Guide to Improving Your Climbing Performance,* Falcon, 2003
Guido Kostermeyer, *Peak Performance*, Luma Verlag, 2001
ISBN 3-930650-01-0

The first two books work very well when used together.

◁ *Markus Schweiger on "Hale-Bopp" (Fb 8a), Fontainebleau/France*

4.1. Warm-up

The main goal of a good warm up is two fold. A good warm-up will create a starting point for muscular performance that will lower your risk of injury. Also, your warm-up should prepare you mentally for the rigors of the workout. We have to make a distinction here between a general warm-up for the entire body, and a specific warm-up based on the demands placed on the fingers and hands during a climbing workout.

The "general warm-up" is best achieved through slow running and other exercises that use the whole body (easy stretching, yoga, Pilates...). During the general warm up, extreme joint positions (i.e. splits or similar) need to be avoided as they can easily lead to injury.

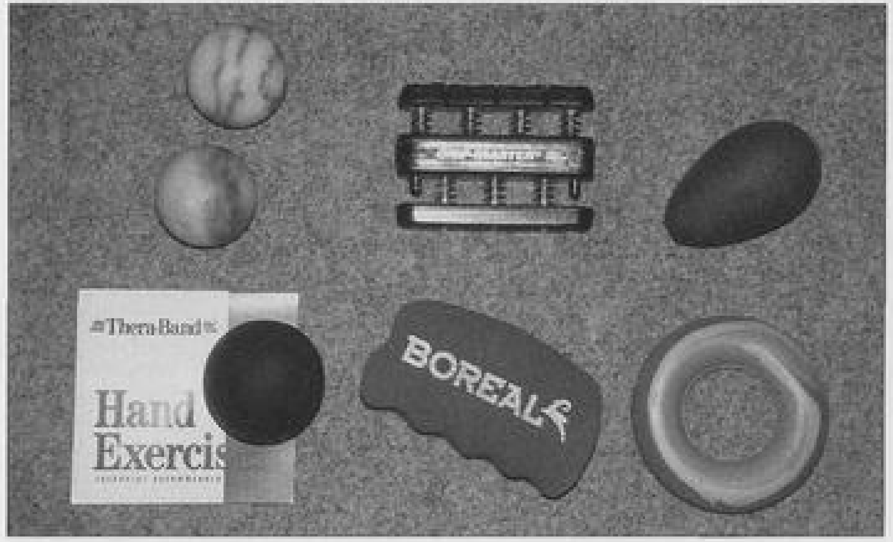
As you speed up your metabolism during the warm-up, there will be an increase in muscle temperature and more synovial fluids will be distributed into the joints. As this happens there will be an increase in the range of motion of these joints and an increase in the flexibility of pulleys and tendons. The amount of blood flow to the area rises and the increased synovia works as a shock absorber for the cartilage. An increase in blood circulation to the muscles increases the enzyme activity and improves neuromuscular coordination. At the same time, this improved blood flow and enzyme activity decreases the friction-resistance in the muscles, tendons, and ligaments. A particularly effective warm-up for the fingers is the squeezing of a foam or elastic ball or the rotating of qi-gong balls in the hand. Also, opening and closing your hands in a bucket of dry rice gets both the flexors and extensors warmed up. All these exercises should be done without straining much. Many hand exercisers demand too much strength and are therefore somewhat dangerous as a warm-up device.

This is also the time to do a light stretching of the fingers, remembering that extreme positions and over stretching during the warm-up can lead to injury. Easy climbing, not requiring any small holds or digit-isolating pockets, is good to do at the start of the warm-up. After a few easy routes you should proceed to something a bit more challenging mentally and physically, but still well below your personal limits in difficulty.

Doing this in a slow progression, with each exercise building in difficulty on the last, will make the body ready to tolerate

higher demands. This effective warm-up takes some time to perform but it is worth the effort. Scientific studies have shown that to bring the pulleys and tendons up to a perfect state of "readiness" requires about four routes or 120 moves of climbing.

Different devices used for warming up.



4.2. Basic Endurance Work Out

A basic endurance workout, that is a low intensity activity like running or swimming where your heart rate is roughly 130 beats per minute (b.p.m.), can be very effective in improving your climbing-specific strength. Good endurance improves muscle regeneration, speeds up lactate degeneration, and increases lactate tolerance. By improving your body's abilities in these areas you will improve your recovery time when you are climbing. Basic endurance workout is not sport specific, which is to say it doesn't matter if you do it through running swimming, skating, or whatever. Just pick one you enjoy. The key is to always perform with low intensity so as to keep the body's metabolism in the fat metabolizing range (the level your body burns fat for energy). If you are above this low intensity (generally 130 b.p.m.) you are burning carbohydrates and perhaps achieving different training goals, but not helping your ability to recover.

4.3. Rest, Regeneration, and Overtraining

There is an old adage used by professional trainers:
"You don't get stronger on your training days. You get stronger on your rest days."
What they mean is a pause in your training, when the regeneration of the muscles and connective tissues can occur, is actually when you will see increases in strength and muscle size. Without a sufficient break in training you will not have that regeneration and will not get stronger. Worse, the continuous breakdown of the tissues involved will eventually lead to an injury.

NOTE

Range of Regeneration	
Hypertrophy-training	48 to 60 hours
Maxpower-training	72 to 84 hours
Strengthendurance-training	48 to 72 hours

The time needed for a sufficient rest is variable in individual people and will be shorter in the highest-level athletes. The more you train, the shorter this time will be. The average rest needed for hypertrophy (to see gains muscle size and efficiency) is from 48 to 60 hours. For complete regeneration you need a bit more time. A power work out, where you are trying to improve on your maximum strength, should be followed by 72 to 84 hours of rest, while an endurance workout needs slightly less, as in 48 to 72 hours. This does not mean that after every workout you need to have 3 days of rest. However, if you want to completely heal all the healthy muscles used in the work out, this time is necessary. A workout utilizing muscles other than those specific to your intense exercise can be done in this period so long as those most heavily affected in the session are given the break.

It is also important that a complete rest, an actual break from the sport, be taken at certain times of the year. For instance, a four-week break in the fall after a very intense summer of climbing generally allows for all the tissues to regenerate and therefore increases performance. Other sports that keep the body working but do not work the climbing specific muscle groups, like running and swimming, could be done during this rest. You can expect a slight decrease in ability, mostly due to the mental coordination required for the sport, when

you return after this rest. However, in the long run you will be stronger and healthier because of it.

The likely result of not taking sufficient rest days and rest periods could be any of a number of overuse syndromes. We commonly refer to this pushing of your personal envelope as over-training. The physical symptoms will become obvious with the various pains (tendonitis in the fingers or elbows, for example), but there are also psychological symptoms to over-training. People who are over-trained can feel chronic fatigue, have trouble with their sleep patterns and suffer night sweats, and experience a high pulse rate while resting. As your physical performance suffers through the result of the injury/injuries, you will probably grow testy and be easily agitated. As athletes, when this happens we tend to alleviate these stresses by doing what we enjoy (i.e. climbing or training for climbing). Obviously this just worsens the problem and puts us in a vicious circle.

You get stronger on your rest days...

It is possible to diagnose someone as over-trained by analyzing their resting and performance heart rates, testing uric acid levels in their urine, and doing a performance diagnostic test. Of course, a base knowledge of where your physical characteristics and abilities are is necessary for this. Rather than do this with scientific testing, you could simply stay aware of your own abilities and monitor yourself. When you see these signs (from the above paragraph) of over-training come up, the most important step is to reduce, or even stop, your workout. You can also help to speed up your recovery from being over-trained by increasing blood flow. This can be done through massage and spending time in a sauna or hot tub. Changing the psychological effects is just as important, and can be done with simple changes in your surroundings, balancing your diet, or taking up another recreational sport with a more playful attitude. Again, the hardest part of all of this will be recognizing when you are over-trained. Know yourself.

From a sports-medicine point of view, the last 10 years have seen many positive changes in the way climbers train for their sport. Provided you adhere to the newer approach to training, you should have little to fear in the long-term consequences of training for climbing. By knowing what the main risk factors are you should be able to train responsibly and safely.

NOTE

Keep in mind these Risk Factors when Training for Climbing

High impact training with additional weight
Short recovery periods
Bad form in training movements
Neglecting important aspects of training
Environment (i.e. cold temperatures)
Age (either too young or too old)

4.4. Content of Work Out

A critical view on certain training contents:

This is not in our hospital – but at the door of the training gym of a famous US climber…

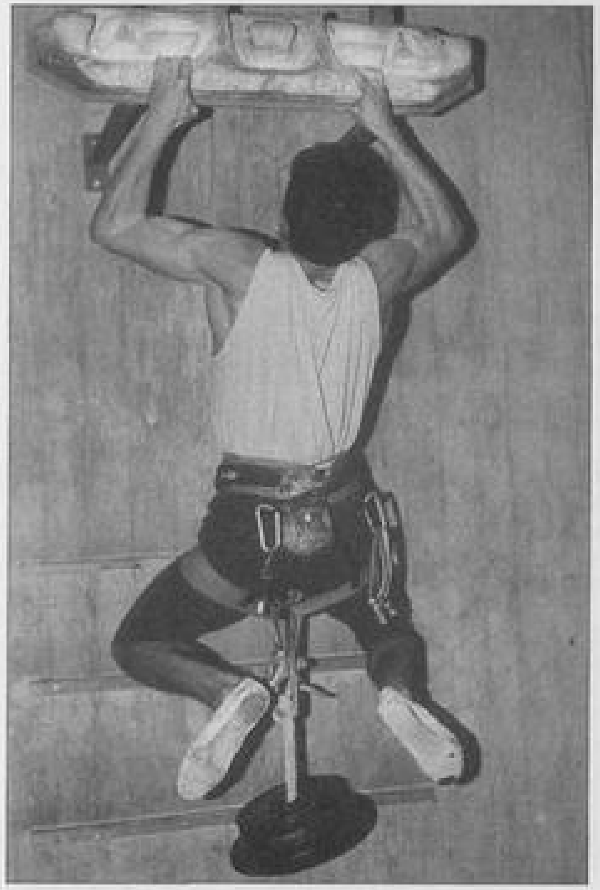
4.4.1. Pull-ups

Pull-ups, one of the basic components to a climbing workout, work the muscles of the shoulders, the latissimus dorsi, and the arms. Many climbers begin their workout with this exercise as it quickly develops muscle tissue and strength. However, pull-ups put a lot of stress on the elbows and a steady regimen of them can lead to elbow problems. Over half of the climbers who report chronic elbow pain also claim they incorporate pull-ups into their workout. Often the origin of these problems is not just in doing the exercise, but also from doing it over and over again in the exact same position. Using the same grip with each routine puts the exact same stress on the connective tissue. A good way to alleviate this problem is to alter the distance between your hands and vary your grip positions (frontal, under cling, sideways) with each set of chin-ups.

Exercise boards help to vary hand positions for pullups (see also 4.4.3).

Another effective workout, though extremely stressful on your joints, is to do negative, eccentric exercises. Note that concentric is to pull up, contracting the muscle to its center, as in doing a curl. Excentric is to prevent the muscle from "tearing", while letting the muscle out. An excentric pull-up is one where you start in a flexed elbow position and lower yourself until your arms are nearly straight. By that we mean to slowly let your self down from the chinned-up position (specifically this is an eccentric work out of the M. biceps and the M. brachialis).

Training with extra weight load



Some climbers will add to this technique by training with a partner who can add weight to their harness when in the chinned up position. This sort of negative eccentric work activates tension receptors that protect the muscle from a tear, which in turn increases the number of muscle fibers that are active.The result is that up to 90% of the muscle fibers are firing during the motion, while in a normal chin-up at most 80% of the fibers are active. Obviously, with more fibers active in the exercise there is a more complete work-out of the muscle.By adding weight, either with a belt or a vest or a partner clipping them onto your harness, you work the muscle even harder.

Though this is the most effective way to gain strength in these muscles, the risk to your connective tissues, and

to the muscles themselves, is enormous. This method of training should only be done by athletes who have been working their muscles for a number of years and who will also respect the rules about taking long rest periods (and even those athletes are pushing the limits of what the body can handle!).

4.4.2. The One Finger Pull-up

Do you really need to be recognized for your strength that much? No, you don't, so don't go doing this as a party trick on Friday night. However, training your fingers and arms to be able to handle the force of a one-finger chin-up has been proven to be effective at increasing climbing specific strength. Most of the work in a one-finger pull-up is done in the upper arms with the finger and forearm only holding one isometric position. For the finger, doing the pull-up is more a matter of accepting the pain than anything else. From a sports medicine point of view, the best training method to achieve this can be found in Guido Koestermeyer's book Peak Performance. In it he describes three major types of training: static, dynamic, and isokinetic exercises. It takes some practice to get the hang of the motions required in these exercises, and one should always start them with a minimal amount of weight, but it is very effective at gaining finger strength.

One-finger pull-up at Coco's Gym, Railae Bay, Thailand

4.4.3. The Training Board

With the development of the artificial climbing wall, the training board has fallen from favor as the best device for climbing-strength development. However it still has its place as a spot to do chin-ups and hanging exercises. There are a few things to keep in mind while working out on the training board. Just as in doing pull-up exercises, don't repeatedly work in the same position without some alteration. Make sure you alter hand and finger positions regularly so as to change the stress points. Also, don't do any exercises from the "crimp" position, as this is the position where your fingers are putting the most strain on all the connective tissues. Avoid injuring your elbows, especially during negative and eccentric exercises, by never fully extending your elbow. Over extending the elbow puts excessive strain on that joint and can cause ligament and capsule instability in the shoulder. As a general rule for climbing, its best to try and build up the tension in the joint capsules, not loosen them.

4.4.4. The Campus Board

The legendary "campus board", built by Wolfgang Guellich and Kurt Albert at the Nuremberg "Campus" gym, has become a household term among climbers. By training for double-dyno's on the campus board, both positive and negative, Wolfgang developed his finger strength for the first ascent of "Action Direct" (the worlds first 5.14d, in the Frankenjura, Germany).

The Campus Board, which should be slightly overhanging and roughly 3 to 5 feet in length, has different holds installed in a repeating pattern. The idea is that you climb up and down, hand over hand, with no help from your feet. This exercise is very effective at developing strength, but it puts extreme stress on your finger joint capsules, joint cartilage, and pulleys. Also, when doing negative eccentric work on the campus board, you put the forearm flexor muscles under extreme stress. When working a campus board into your workout routine, it is important to make sure you vary your exercises and don't become addicted to the strength gains you will see through this device. Excessive use of the campus board will lead to an injury if you are not careful, are not taking sufficient rest days, and are not altering the types of holds you are using. Campus board exercises should not be performed at the end of a work out as the lack of coordination and over all exhaustion of your muscles will take away some of the control you need to do this safely.

4.4.5. The Double Dynamo

Double dynamos on the campus board are done by doing a pull up, then letting go with both hands and jumping up to the next edge. This is thought to be even more effective when doing a negative double dyno. The theoretical basis for the negative eccentric double dyno is through reactive, or plyometric, training. For instance, when you jump down off a box your leg extensors use reverse-tension to catch you. The thinking is that this reverse tension helps develop the muscle to be even stronger when it contracts to jump again. So in theory, each time Kobe Bryant lands after slamming the basketball, he has helped develop a bit more strength for that next dunk. Again in theory, if it works for Kobe, the same philosophy will hold true for the flexor muscles of the upper body. Or not. The fact is that this form of exercise may not be more effective for training than other, safer, practices. The risk of injuries to the fingers and shoulders are very high if the jump/drop that is performed is missed or not caught correctly. The short of it is that only the very strongest athletes should attempt it, and even then, do it sparingly. Dropping onto your arms works well in the movies, but it could cost you a lot of down time.

Double dynamos put high stress on the finger joints and pulleys.

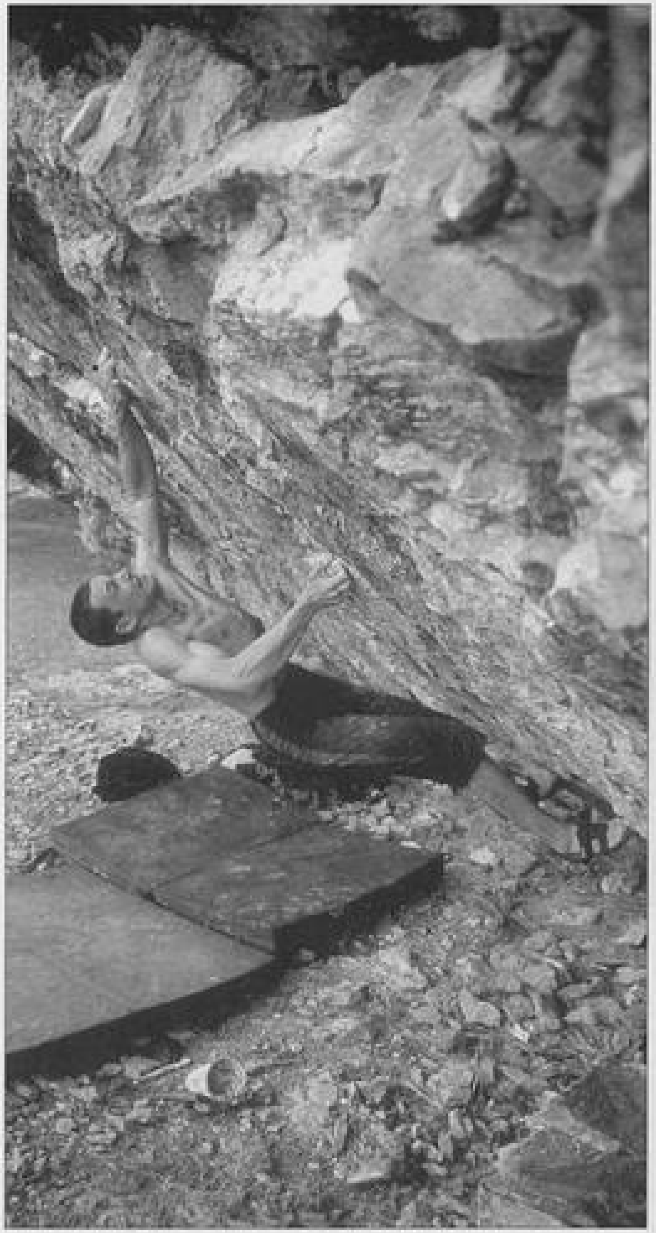
4.4.6. Bouldering

Like sport climbing, bouldering was once a form of training, but now is becoming a sport in itself. There are now international level competitions dedicated to bouldering at the highest levels of difficulty, and at these competitions you can often find injuries of nastiest ilk!

Bouldering could be defined as the focusing of the most powerful bits of a route into the shortest possible distance. Obviously that means you are putting the most strain possible on the body. Because those intense moves might be easy to access, you will be drawn to try them over and over again, there by putting the same intense stress on the joints over and over again. Just to make the conditions more ripe for injury, this sport is often done at lower temperatures (you get better friction in the cold) when blood flow to the fingers is slowed.

All of this combined means you should be very careful when bouldering. A very thorough warm up, and perhaps even keeping gloves on your hands between tries even if you don't feel that cold, is important. Another common area to be injured when bouldering is the wrist as instinctively a climber will try to slow his/her contact with the ground by putting out his/her hands. A boulder pad, and bouldering partner to help spot you, are two of the best ways to avoid injury.

Your best protection when bouldering: a spotter!



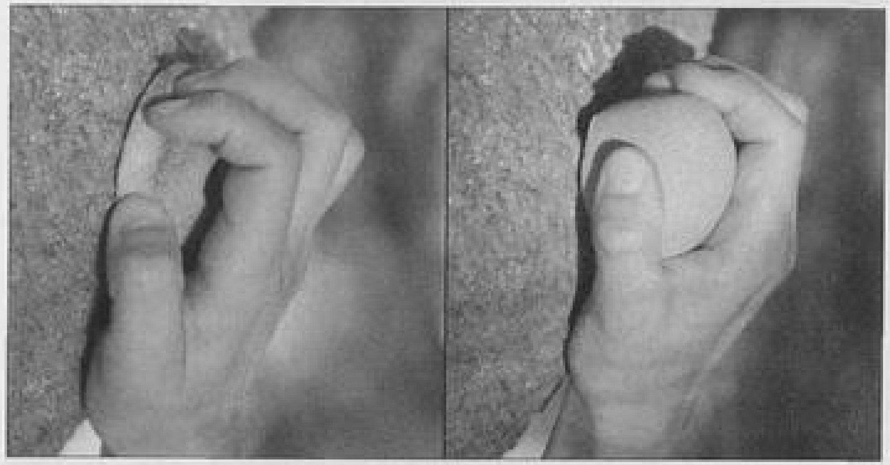
Make sure the crashpad is where you fall off! (Volker Schöffl on »Torero« (Fb 7c), Billitscher)

4.4.7. Artificial Holds

Left:
Bad example of an artificial hold. Note the sharp cut edges putting high pressure on the tendons and the soft connective issue.

Right:
An ergonomic hold allowes you to position all finger digits onto it.

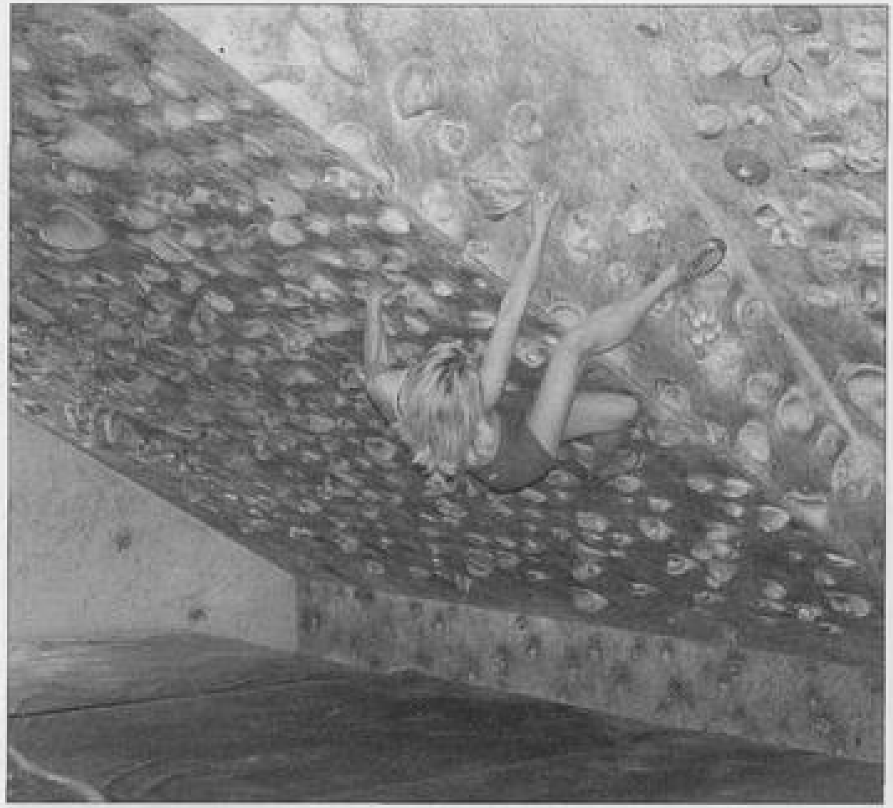
The first generation of holds was in no way ergonomically designed. The first hold makers tried to recreate the rock, so they put irregular edges, sharp pockets, and shallow crimps together in their designs. Generally, on the smaller holds, the fingers had to be in a crimped position in order to maintain a grip. Injured fingers were often the result. Since then, athletes, sports science, and the manufacturers have come together and recognize that a hanging finger position, a position where you are on a more "slopey" hold, is just as good for developing strength but much safer for the hands than the crimping position. The manufacturers are now designing holds to be easy to grab and close your fingers on, but more round, smooth and devoid of sharp edges. Some companies, like Entre-Prises®, have brought sports medicine doctors into the design process of the holds.



NOTE

Important features to think about when buying holds:

- Look for an ergonomic shape with round slopers rather than holds you must crimp
- Make sure the holds have a backside layer that keeps them from spinning when on the wall.
- Look for a fine-grained surface that won't tear your hands up



Bouldering on indoor walls is probably the most effective and complex form of training

4.4.8. Indoor Bouldering

The most efficient, as well as the most complex, way to develop power for climbing is to actually climb on an artificial bouldering wall. Some climbers experience the largest increases in their strength after one season of training on an artificial wall, but the gains in strength come with a cost. The increases in power and strength you can see with this sort of training often occur so fast that the passive structures, the bones, ligaments, and joint capsules, are left behind. This is especially the case for beginners, with tendovaginitis being the most common injury.

4.5. Holding Positions

The hold that puts the least stress on your finger tendons is the one that allows the most contact between the pads of the fingers and the surface of the hold. That is to say, the more of your fingers and the more of each finger that can bear weight on a hold, the less stress there will be on any single tendon. The position with the least amount of strain, as well as optimum strength development for the flexor muscles, is a slight hyperextension of the wrist on a large sloping hold.

The biggest strains to the ring finger occur when a hold is slightly out of reach for the outer fingers (ring and pinky) and you have to tilt the hand to get a good purchase. What often happens in this situation is that the pointing and middle finger get good contact with the hold, but the ring finger is not completely on the edge and is left a bit straighter (the pinky will likely have no contact with the hold). This position is very hard on the connections in the ring finger, especially the pulleys, and is one of the most likely ways to bring about an injury. Placing the shorter finger on the edge next to the longer finger means the shorter one must make contact on its tip, thus increasing the mechanical advantage and increasing the stress to the connective tissue.

The positioning of all fingers on a hold places the least amount of stress on the tendons.

With the exception of pulling on one-finger pockets, the most extreme and potentially dangerous holding position is the crimping position. Because of the mechanical advantages created by flexing the tendons in this position, the maximum strain on some digits can be several times your body weight. The two flexor tendons are under the highest angle of flexion here and are therefore placing the highest amount of friction on the sheaths and pulleys. This friction obviously can be doing damage to the tendon sheaths, and inflammation in the last two digits is not uncommon. Also, doing lots of crimping leads to overstress of the pulleys, and pulley tears are one of the most common hand injuries to climbers.

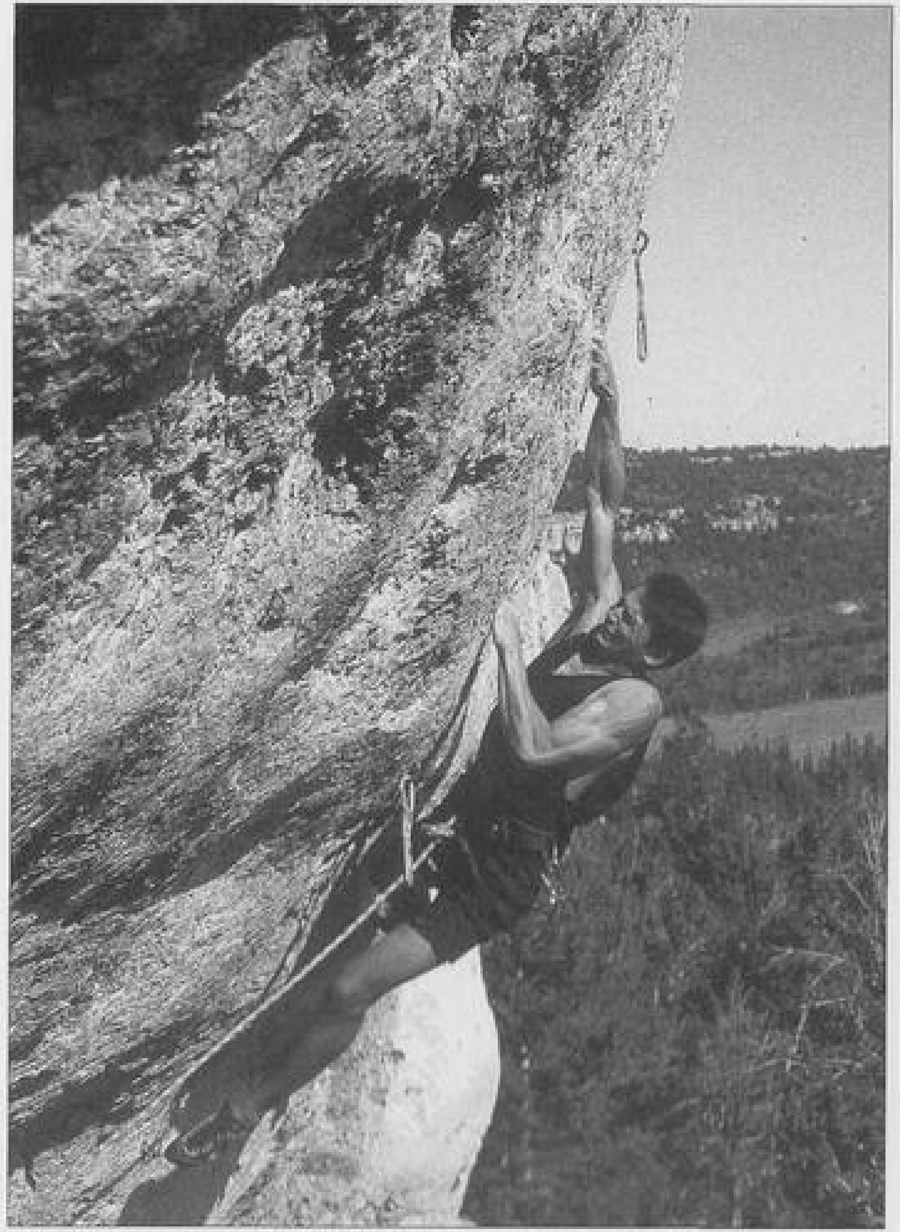
The so-called "crimping" position puts the most stress on the flexor tendons and can easily bring on an injury.

When pulling on a one-finger pocket the weight of the entire body hangs on just one tendon and joint capsule.

During a training session, Wolfgang Guellich once said, "The only advantage to pulling on a one finger pocket is that none of the other fingers are under stress." This is pretty much the truth. When pulling on a one-finger pocket you can easily put the entire weight of the body, or more, on a single 4 mm in diameter tendon. Just as food for thought, keep in mind that your knee, another hinge joint like the finger joints, has developed specifically to take this same load. Now compare the size of those hinge joints! Since the pointing and middle fingers are generally the strongest, they are the most likely to be used in one-finger pockets. Some climbers have such large fingers that they have to develop their ring finger and pinky to do a lot of mono work, which is even smaller and therefore subject to more stress for its size. There is no doubt that if you climb at higher levels, you will pull on one-finger pockets. Be for warned; it can lead to a devastating injury.

The twisting of the fingers into the "finger-lock" position in a finger crack can be painful if you aren't used to it, but appears to not have as high an injury rate as the crimping position.

The finger lock position is sometime painful but does not have as high a risk of injury as the crimping position.



Important Guidelines for Training

1. You should vary your training method by using different exercises and different shaped holds. This will prevent injuries related to over exercising in the same position.

2. It is important that you do not limit your training to only the finger flexor muscles. The extensor muscles also require exercise so as to keep from developing an imbalance in the forearm. An imbalance in development can lead to elbow and wrist problems as the finger extensors help to stabilize these two joints. The finger extensor muscles require special training, like the use of a rubber band to resist the opening of the fingers.
   The inward rotating (pronating) muscles also need to be trained to counter the outward rotation of the biceps. All exercises for the upper arm flexors (curls for instance), as well as all hanging exercises and all pull-ups, need to be performed with an inward rotated forearm. (For an explanation of why, refer to Chapter 1.)

3. The development of maximum power should not be the only training you do. Training for endurance is just as important and the development of both will be healthier in the long run. Flexibility and coordination should also not be left out of a training program.

4. Training the fingers on edges larger than 2cm across, basically a full first pad, is less stressful on the joints than training on a smaller edge. Since the development of muscle occurs at the same rate on the larger edge, it is advisable that you never train on anything smaller than the full first pad.

5. Training the fingers for maximum power, for example training with extra weight or dynamic movement such as on a campus board, should be done rarely with long rest periods between. Only athletes who have developed their bodies for a long time and are trying to hit a peak in their training should perform these exercises. A long rest period should always follow.

6. Training needs to be stopped before you reach total exhaustion. When the arms are completely exhausted the connective tissues are often loaded with most of the stress and are therefore much more likely to be injured. Also, any sudden pains are, at the very least, a sign you are over training that area. You should rest following any sudden pain.

7. All exercises where the joint is at its furthest extension should be avoided as they put excessive stress on the cartilage and connective tissues. Examples of these over extension exercises are pull-ups where you drop all the way to a "dead-hang" (thus placing the stress on the elbow and should joint connections and not the muscles) and finger board work where you are in a crimping position.

8. General endurance training for the whole body, as in running or swimming, needs to be a part of any training program.

Remember the Following Points (When Climbing)

1. Too many tries on the same route or same move, with only a short recovery period, as is so often the case when "projecting", are dangerous.
   If you find yourself repeating the same movement over and over again it is wise to pick a route that is slightly easier.

2. Breaks between redpoint attempts on routes that are at your absolute limit should be around 60 minutes. Thirty minutes should be considered an absolute minimum and probably will not be productive (i.e. you'll be givin' it another try!)

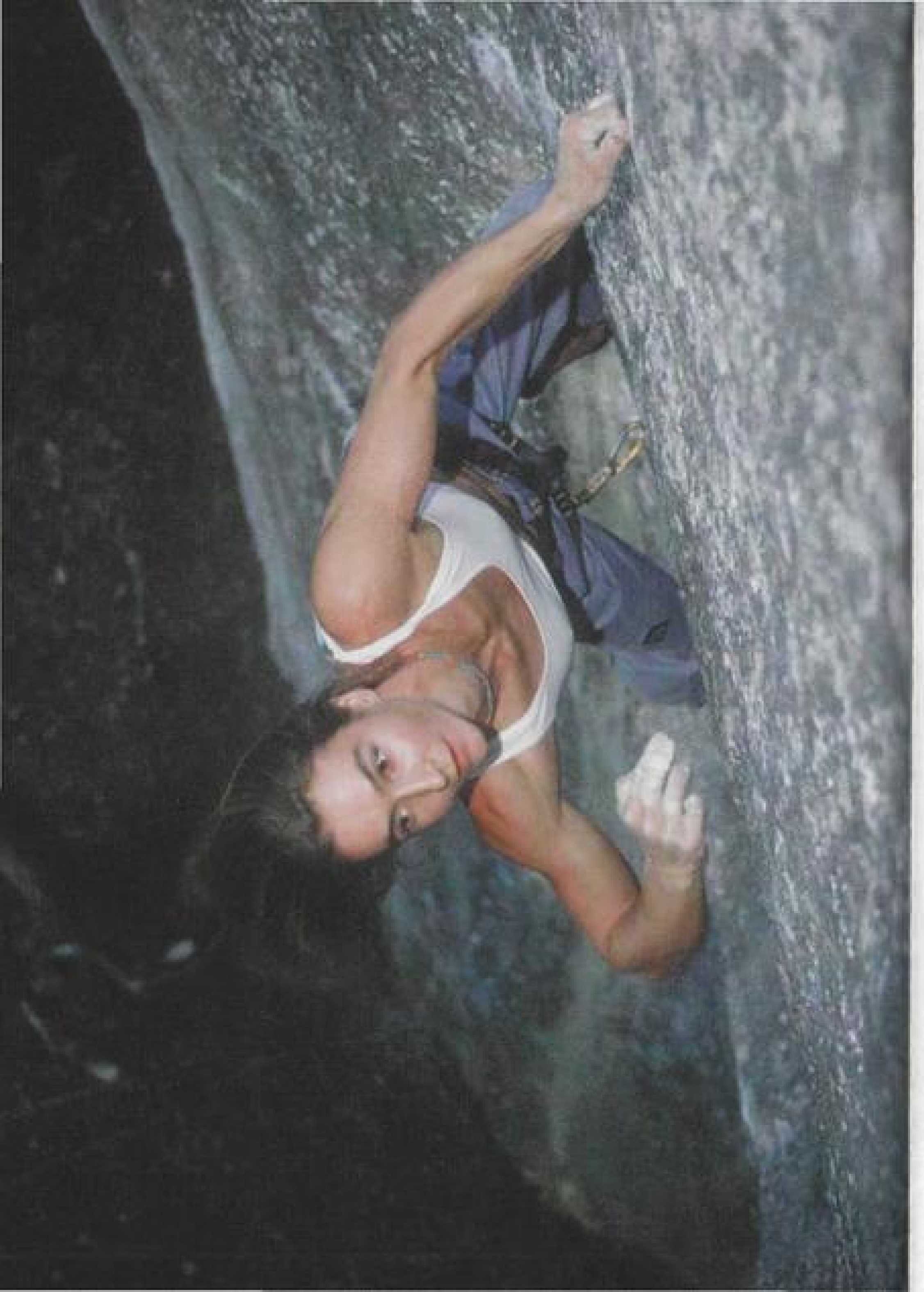
3. If you pop off a hold, re-grabbing it is not an option. Pulley injuries are common when this is done, and the connections in the elbow and shoulder are going to be put under a serious amount of stress if your hand does somehow survive it.

4. Large dynamic moves and pulling on one-finger pockets should only be done when absolutely necessary.

5. If you analyze an overuse syndrome and think it might be connected to a particular style of climbing (for instance climbing with un-flexed elbows or regularly dropping onto a completely straight arm), special training is necessary. You will need to teach yourself, by approaching certain climbing sessions as training sessions, not to climb in that manner.
   Take the time to do this and your climbing career will last a lot longer!

6. Any time you feel a sudden pain, aside from the obvious surface pain that goes with clinging onto rough edges and pockets, you should stop climbing.

7. Climbing on artificial holds is more intense than climbing outside. Pulling on plastic should be done on anatomically shaped holds and should be broken up with long rests between climbs.



5. Stretching and Muscle Development

Flexibility training, otherwise known as stretching, has not always been accepted as a necessary component of training. For a long time well-trained athletes either ignored stretching or, in some cases, outright rejected it. Some sports-medicine doctors and trainers even claimed that stretching would take away much of the necessary muscle tension that gave athletes their power.
This mode of thinking is now being rejected across the board, and all but a few top-level athletes are incorporating stretching into their daily training program. For climbers the movements of high stepping and stemming, both of which require flexibility, are absolute musts to master. These techniques, as well as others like "drop knee", can only be done by incorporating a good stretching routine into your training. In the isolation room of a World Cup climbing event, pretty much everyone is stretching so as to get the maximum performance when their time comes. However, for some reason the average weekend-climber still hasn't incorporated stretching into his/her training routine.

Why Stretch?

- Reduced risk of injury
- Increased efficiency of the muscles
- Increased flexibility and thus a longer reach
- Prevention of muscle aches

NOTE

5.1 What is Stretching and How Does it Work

Every joint in the body has an assigned range of motion which is dictated by the bone structure, the joint capsule, the ligaments, and the muscles and their connective tissues.

◁ *Marietta Uhden on »The Face« (10–), Altmühltal/Germany*

Most of these structures are fixed in their range of motion, but the muscles are safely capable of increasing and decreasing a joints range of motion. As an example of "decreasing" the range of motion, following an injury the fascia and the muscle body itself are likely to develop scar tissue that will decrease the muscle and the joints flexibility. Even without injury, the muscles will tighten up during their development and, over time, restrict the joints mobility. Stretching, as we define it, is the systematic pulling of the muscles to increase their over-all flexibility.

NOTE

Reasons for a Reduction in Range of Motion

- Lack of exercise
- An imbalance of one side of muscles (i.e. flexors vs. extensors)
- Repetition of the same motions
- Muscular hypertrophy
- Bad coordination

Good flexibility allows a muscle to be used in a smaller percentage of its range of motion. Therefore, optimum efficiency of a muscle can only be reached with good flexibility.

Stretching before an activity helps activate the nerves so they are prepared for the stress of exercise. Also, it is known that a muscle and all its connective tissues have more elasticity and are thus less prone to injury when they are warm. By stretching before a workout, you will raise the temperature of muscle and give it a larger range of motion to work in.

Stretching should be done on a daily basis. It is important that stretching be done before and during exercise, but also following exercise, as that is the time your muscles develop adhesions which will inhibit flexibility.

NOTE

When to Stretch

- As part of the warm-up
- After a workout
- After climbing

5.2 General Guidelines for Stretching

Stretching is the act of safely putting the muscle in a position that lightly pulls its body. When learning how to properly stretch, you should be able to feel the sensation of "stretching" and aim for that when doing any stretching exercise. Each stretching exercise needs to be learned by you as an individual because the exact positioning varies slightly from person to person.

The first step is to find the correct starting position:

It's important to keep in mind that the joints around the muscle have a correct position to be in for a given stretch. As an example, the flexor muscles of the forearm cannot be stretched if the elbow is not extended. The flexors run from the fingers through the elbow, and a bent elbow shortens the distance the muscles must be pulled in order to stretch. For this reason, the elbow must be straight in order to put the flexors in their natural pre-tension position. Without putting that joint, or another joint in its optimum position the stretching exercise will be less effective. Even worse, you might not stretch to muscle body and instead stretch the connective tissues that should be left with their built in tension.

The Four Steps of Stretching:

Knowing the four steps to an effective stretch, commonly recognized by the acronym C.H.R.S., will make your stretching routine far more effective. C.H.R.S. stands for "contract", "hold", "relax", and "stretch". Normally, stretching a muscle activates receptors that tell the muscle to work against the stretch so as to prevent a possible tear. However, if you activate the muscle with a contraction, hold that position, and then relax just before stretching, you will be able to stretch without the added muscle tension. This release in tension occurs because the muscle spindle receptors, which send various protective messages to the brain from the muscle, need a short recovery period after activating. By stretching during that recovery period you are able to catch the muscle at a vulnerable moment and thus pull it a bit farther. Obviously you need to be careful when doing this as the muscles natural defense against being torn is being removed.

Steps to C.H.R.S.:

1. Find the starting position of the stretch and contract the muscle.
2. Hold that position for five to ten seconds so the muscle spindle receptors have to take their usual break during the next step.
3. Relax the muscle. At this moment you are getting that momentary release in tension.
4. Now pull the muscle into the "stretch". Be very careful not to stretch it too far.

Remember: your body's natural defense against strains and tears has been deactivated by doing steps 1-3.

This exercise should be shown to you by a trainer or physiotherapist and should be done carefully as it is easy to over stretch the muscle. Generally the exercises are done with three repetitions and with the stretched limb or muscle getting a good shakeout and rest between.

It is easy to get hurt when stretching. To minimize the risk, keep in mind these frequent mistakes:

1. Doing your stretching with quick motions, rather than slowly building the tension of the stretch, is dangerous and non-productive. When you try to force a stretch by moving into the stretched position quickly, your body responds by increasing muscle tension to protect the connective tissues. This actually has the opposite effect of stretching as it is a constriction of the muscle. If you then try to force the stretch, it can cause a tear or a rupture. Stretch slowly!

2. Your stretching routine should not harm your joints. Long muscles that span numerous joints, for example the flexors in the forearms and hands, should not be stretched through the smaller joints. In other words, don't stretch those big muscles by pulling back on your little fingers! Its best to stretch long muscles through their largest joint. In the case of the forearm flexors, stretch them through the wrist.

3. Stretching with a partner who is quite a bit more flexible than you is often less effective and can result in injury. This is because most people will automatically try to do what their partner is doing. If your partner is very limber and you are not, the position you try to reach could cause injury. Remember; "A man needs to know his limitations". Dirty Harry, Magnum Force

4. Acute injuries, like muscle strains, tears, and joint injuries, should not be stretched. At the very earliest, you might be able to start a limited stretching program 10 days after a light muscle strain. However, your doctor should advise you on this as he/she understands the severity of the strain. At some point following a strain you will need to stretch as the change from scar tissue to functioning muscle tissue, as well as the blood flow, are aided though stretching.

5. Stretching is not intended to increase the mobility of joints that are already very flexible by nature (an example would be the cervical spine which is extremely flexible in its design).

6. Some stretches, like the hurdler sit (one leg pulled up to the groin with the other straight out) are poison for your joints. This stretch in particular places an enormous amount of rotational stress on the lower back. Also, some of the stretches commonly used in certain forms of yoga stretch the joint capsules too much. Talk to a physiotherapist or doctor about your stretching routine.

7. Popping your fingers by pressing them beyond where they naturally want to bend, as well as pulling them until they pop, is not good. This is simply stretching the joint capsule and creating an environment that is ripe for injury. Slight pulls and stretches of the fingers are good as the help increase blood flow, but going until you hear that popping sound is very bad for your climbing.

5.3 Stretching Exercises

5.3.1 Stretching the Mm. lumbricoles und Mm. interossei

The muscles in the hand (Mm.lumbircales and Mm.interossei) are very small, but they are important for the fine movement, coordination of the fingers, and for stabilizing the finger joints. If these muscles are too tight, the fingers cannot be completely straitened and therefore lose a lot of their function. Most people don't have to worry about overly tight finger and hand muscles, but climbers injure and over work these muscles regularly and therefore do suffer from hand tension. Also, pulley ruptures heal better and faster if these muscles are kept lose.

Exercise 1:

Starting Position

Place the palm of your hand on a base (the edge of a table works well) with your fingers hanging over the edge of said base. Your wrist should be slightly bent. Flex the finger you want to stretch so that it is completely folded under your palm. Place your other hand over the top of this hand so that the fingers are able to press on the back of finger you choose to stretch.

The Stretch

Hold the palm down on the base with your thumb and lift the finger back and up. As you do this, flex the finger against the pull so that the muscles are activated. Hold that for about 5 seconds, then relax. Now hold the stretch for 15-60 seconds.

Mistakes

Do not do this stretch with an extended elbow as this tightens the flexor muscles.
Make sure the wrist joint is not flexed too far. If your wrist is excessively flexed, some of the pre-tension in the flexor muscles will be removed and you will not be able to actually stretch them.
Always completely bend the finger you are stretching before starting the stretch.

Modification 1

While you have the finger in the stretched position, slowly work it back and forth from side to side (thumb to pinky).

Modification 2

Do this same exercise without the base and without having your wrist flexed.

Starting Position

The Stretch

5.3.1 Stretching the Mm. lumbricales und Mm. interossei

Exercise 2:

Starting Position

Bend your elbow to roughly 90 degrees and turn your palm upwards. Next, flex the outer digits of your fingers but do not make a fist of your fingers. With your other hand, put your index finger across the last digit of the finger you will be stretching and place your thumb under that finger so as to hold it in position.

The Stretch

Pull down slowly with the index finger so that you pull back on the bent finger against the direction that it flexes. Hold that position for about 5 seconds, and then relax it. Now pull back again for 20 to 60 seconds. Do this three times to each finger.

Mistakes

Make sure your hand is over extended.
Do not flex your elbow too much.

Starting Position

The Stretch

5.3.2 M. supinator

This is a stretch of the forearm muscles with an emphasis on the supinator. This muscle regularly suffers overuse syndromes near the wrist and elbow (tennis elbow). It can also be the cause of supinator syndrome (see Chapter 3) which is a compression of the nerve as it runs through the muscle. If this muscle becomes too tight it is difficult to extend the elbow when the arm is rotated inward.

Starting Position

Sit on a bench or chair with your legs slightly spread. Lean forward and place the back of your left hand flat against the thigh of your right leg. Your upper body should pivot slightly towards your right side and your elbow should be slightly bent.

The Stretch

Now straighten the left elbow and rotate the shoulder outward. You should begin to feel a stretch on the dorsal side of your elbow. Hold that position for 5 seconds, and then relax for as much as a minute. Now do it again holding the position for 15 to 60 seconds. Do it again with the other hand.

Mistakes

Make sure the arm is straight with the elbow fully extended.

Starting Position

The Stretch

5.3.3 Extensor Muscles

Tennis elbow is a common overuse syndrome in athletes. When we examine people with this condition we usually find that they have excessively tight and short extensor muscles. In a healthy arm you should be able to fully extend your fingers while your wrist is flexed at a 90-degree angle. Many climbers cannot do this!

Starting Position

Bend your elbow, wrist, and fingers, and cup the fingers with your other hand.

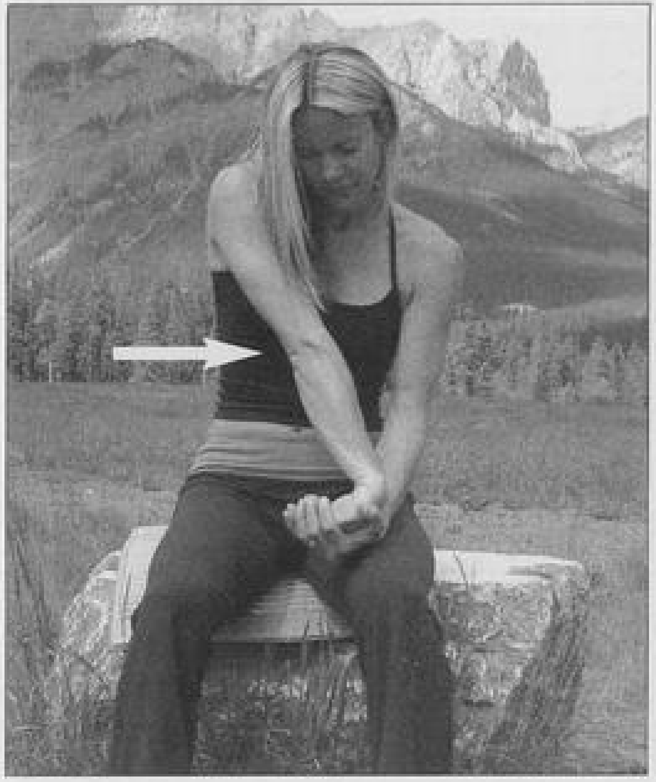
The Stretch

Now extend the elbow. Hold that position for 5 seconds and then relax and bend the wrist and fingers even more. Now extend the elbow again and hold it for 15 to 60 seconds. This stretch can be increased by rotating the elbow to the outside after you have straightened it.

Mistakes

Make sure you fully extend the elbow.
Do not allow the wrist to straighten. It must stay fully flexed for this stretch to work.

Starting Position



The Stretch

5.3.4 Flexor Muscles

The flexors, being so heavily used in climbing, are very tight and commonly suffer from overuse syndromes (golfers elbow). A healthy person should be able to bend their wrist back 90 degrees without forcing it back with the other hand. However, many serious climbers have a hard time reaching this full level mobility.

Starting Position

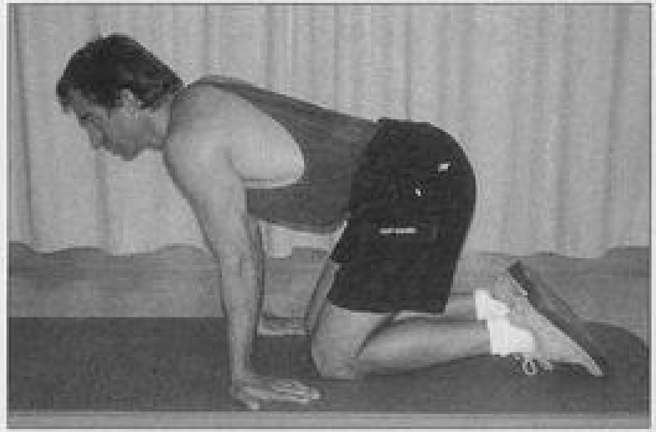
Get down on all fours with your palms down and your fingers aimed back towards your feet. Completely straighten your elbows. You should start this leaning forward so that it is easy to put the palms and fingers completely flat on the ground (If you can't do this, you might want to see a physiotherapist!)

The Stretch

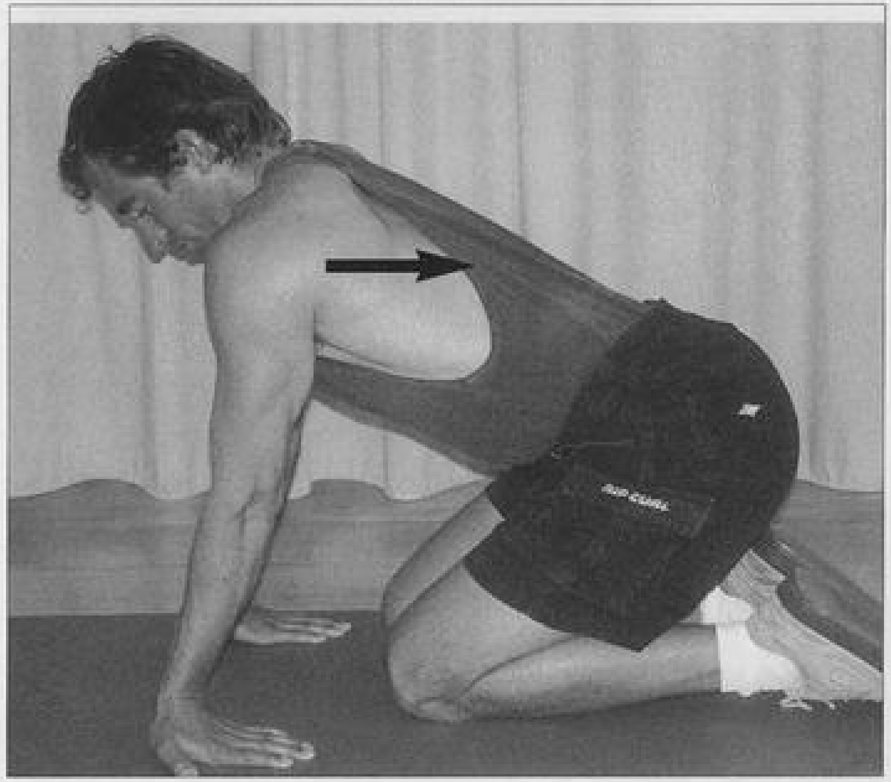
Straighten the elbows and then rock back so that you feel the tension and stretch in the forearms. As you do this, gently try to extend your hands at the wrist. Hold this for about 5 seconds, then release. Now move the hands forward a bit and rock back again, this time holding the position for up to a minute.

Mistakes

Make sure the finger joints and the elbows are fully straightened.



Starting Position



The Stretch

5.3.5 Biceps

An excessively tight biceps muscle will affect the function of the forearms and shoulders. Also, climbers regularly suffer from tendonitis in the biceps tendon where it inserts in the shoulder.

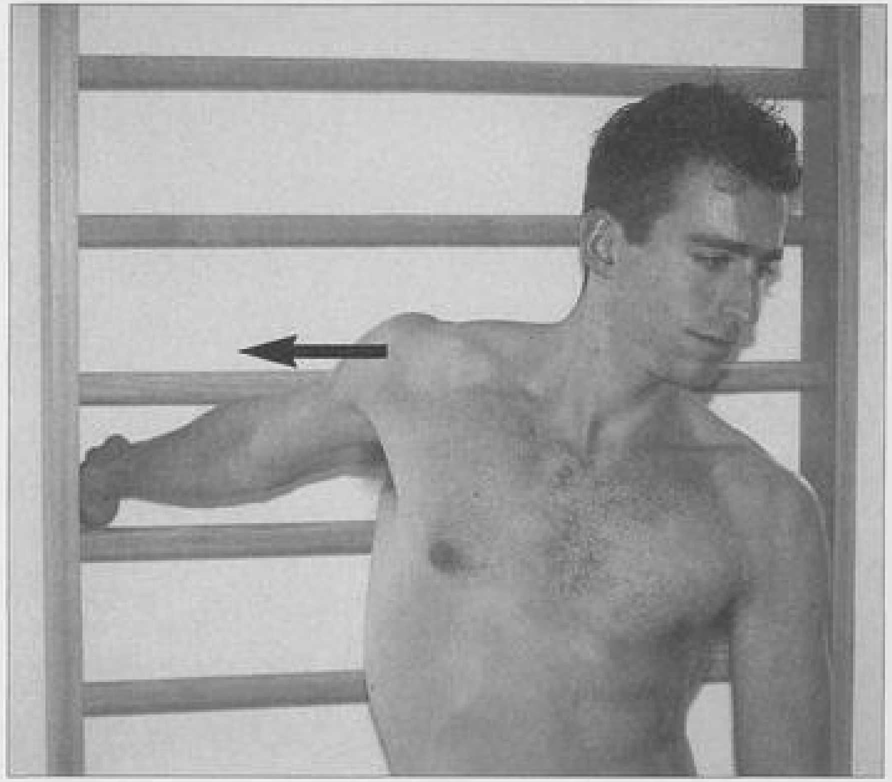
Starting Position Press the back of the hand against something so that you can twist and it will stay in place. A doorframe works well.

The Stretch Using your chest muscles, pull the arm forward with the hand held in place by the doorframe. You should feel some tension in the biceps. Flex the biceps for 5 seconds, and then release it. Now do it again, this time going a bit further with the stretch. A twisting of the upper body is usually how you really push this stretch. Hold this position for up to 60 seconds.

Mistakes Make sure your elbow is totally straight.
Don't stand up to straight. Bending a little in your lower back will intensify the stretch, while overextending your lumbar spine will weaken the stretch and put pressure on the spine.

Starting Position

The Stretch



5.3.6 Pectoralis major

Excessively tight chest muscles are pretty common. If so, adverse effects can be felt in the spine and the shoulder joint. As a reaction to the pain of syndromes like golfers elbow and tight biceps muscles, your body will often tighten up the pectoralis major. The previous stretch of the biceps will have some stretching effect on the pectoralis, but this stretch is also necessary to keep the chest muscles healthy.

Starting Position

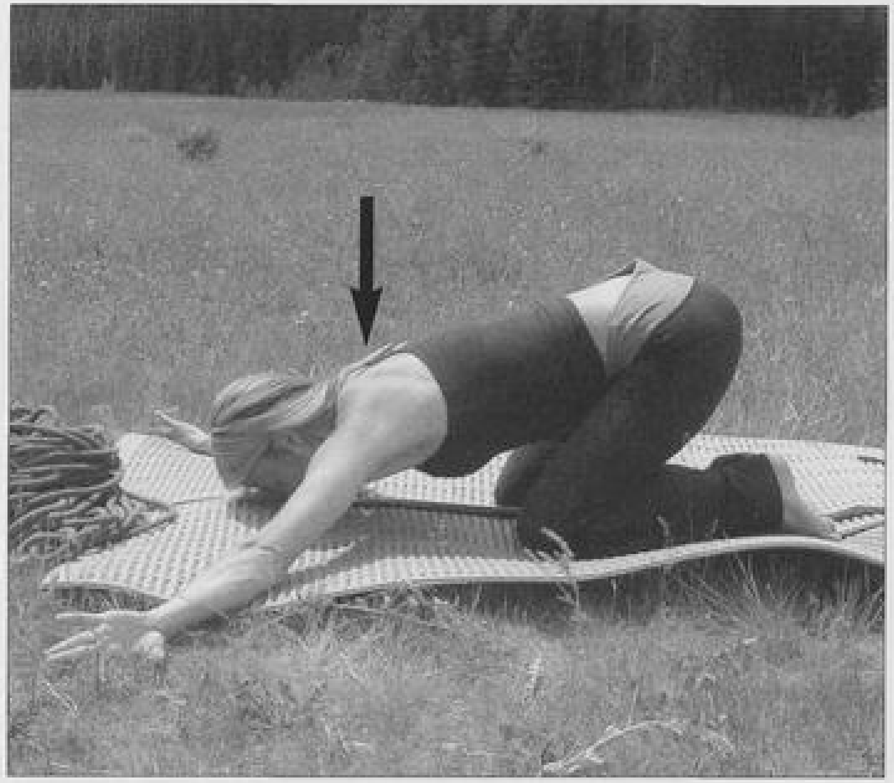
Get down on all fours placing your hands so that the thumbs are pointing outward and the backside of your hand is contacting the ground.

The Stretch

Rock backwards while pushing your chest down toward the ground. Do a warm up of 5 seconds, then rest, and do another of up to 60 seconds.

Starting Position

The Stretch



5.3.7 Triceps

As the triceps is the muscle that extends the elbow, it often becomes excessively tight in climbers. X-rays of climbers who have been active in the sport for years often show a degeneration of the bone around the triceps tendon insertion, thus indicating an increase in stress on it. Stretching this muscle regularly will help to lower the stress on those tendons.

Starting Position With your elbow fully flexed, lift your arm as high as possible; you're trying to point at the sky with your elbow.

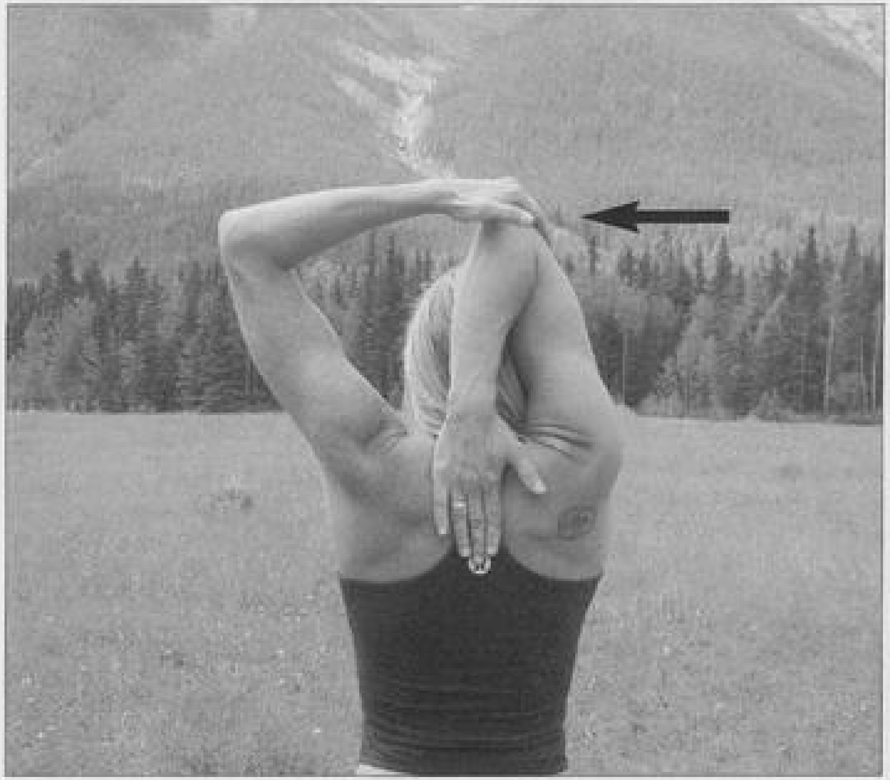
The Stretch Reach up with your other hand and pull the elbow further up and behind your head. Hold this for 5 seconds as you pull the elbow against your other hand. After the five seconds, relax the arm and then go into that position again for up to 60 seconds.

Mistakes Do not flex your neck or thoracic spine while you do this stretch.

Tip This stretch also helps remove tension from the shoulder joint capsule and can help with pain in the bursa subacromialis. However, if you have acute inflammation in this bursa you should not do this stretch.

Starting Position

The Stretch



5.3.8 Iliopsoas muscle

The iliopsoas, more commonly referred to simply as the "psoas" (pronounced "so-az"), is one of the strongest muscles in the body. Because it flexes the hips and runs from the upper legs to the lower spine, the psoas muscle gets a lot of work. For this reason it is often a very tight muscle. The psoas can often be the source of pain in the lumbar spine. It can affect all aspects of the way you use everything from your hips to your neck. Without regular stretching, the psoas muscle can often become so tight that intensive physiotherapy is required to relieve it. It is known that the pain associated with an excessively tight psoas (as well as quadriceps) might not be relieved until months after the stretching routine has begun.

Starting Position

Drop down on one knee with your body erect and slightly shifted to the right. The left leg should be bent at roughly a 90-degree angle in front of you. Your right leg should be at roughly a 90-degree angle directly below your trunk and with the foot pointing slightly to the outside. If your balance is as bad as mine, you might want to have your left hand on a chair or bench.

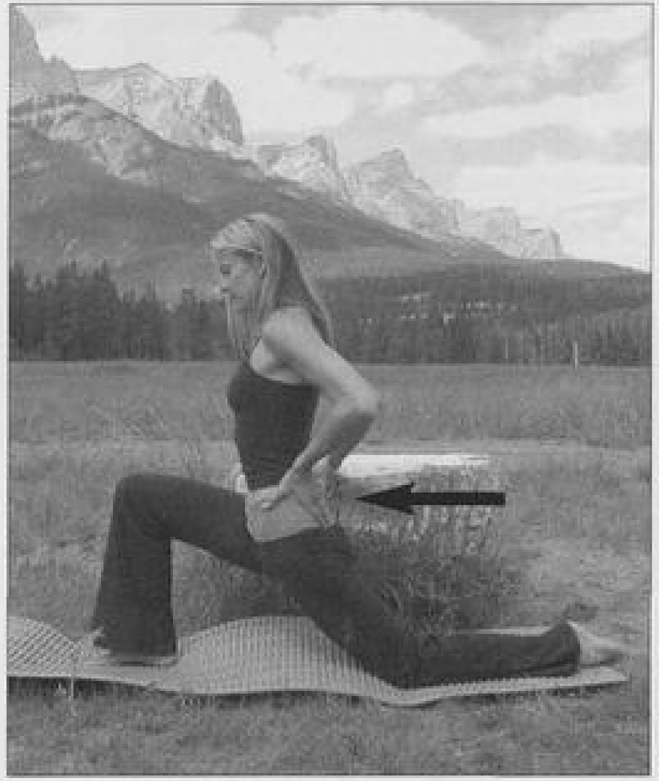
The Stretch

Place your right hand on your hip and slide the hips forward until you feel tension on the right side. Flex the hip as if you are trying to pull the knee forward for 5 seconds, and then release it. Now move the hip and body forward slightly leaving the right knee in the same place on the ground. Push the stretch again, this time holding it for up to 60 seconds. Now switch sides.

Mistakes

Don't let your upper body go to far to one side or the other. This will move you out of the stretching position. You have to keep your body in the right place so that you feel the tension in this stretch.
Make sure you do not flex the hip. The hip should remain relaxed while it is stretched.
Don't forget that your "rear" foot needs to be slightly to the outside of the plane of your body. This is a key bit of the positioning for the stretch.

Starting Position



The Stretch

5.3.9 Rectus femoris

The quadriceps is the strongest muscle group in the human body, and of the four quadriceps muscles, the rectus femoris is the most powerful. This muscle flexes the knee joint and helps to operate the hips. Just as with the Iliopsoas, the quadriceps can become very tight and then cause problems in your knee, hip, and lower back.
It is common for the rectus femoris muscle to become so tight that the other muscles in the group, like the vastus medialus, become weaker and thus more susceptible to injury.
Climbers often don't realize it, but we put our quadriceps under considerable strain. High step moves in sport climbing often require one to do what amounts to a one-legged squat. If you try and do a one legged squat in the living room without the support of adrenalin and the will to reach the top of the route, you will find its quite difficult. With such strain on the quadriceps and rectus femoris, it follows that proper stretching is important.

Starting Position

Place your left hand on a chair or railing for stabilization. Hold your right ankle with your right hand and stand totally erect over your left leg. Do not overextend the lumbar spine (i.e. bend backwards).

The Stretch

Lift the right foot completely to your butt. At the same time, allow your right knee to shift behind you (i.e. relax the hip). You should feel a stretching in the hip and upper leg. Now flex the lower leg against your right hand as if you were trying to straighten it. Hold this position for 5 seconds, then release it and do it again for up to 60 seconds. Now do it to the other leg.

Mistakes

This stretch is difficult, as a tight muscle tends to cause an overextension of the lumbar spine. If this is the case and you are not able to do it without overextending the spine, you will be placing extra stress on the discs between your vertebrae.
Make sure you totally extend the hip (bring the knee behind you). Do not let the leg you are stretching shift to the outside. It must stay in its standard walking plane.

Tip

If this muscle is extremely tight you should probably do the stretch while lying down and place a cord around the ankle so you can reach it. We recommend that if you are that tight, you see a physiotherapist. Anyone that tight is probably doing constant long-term damage to their hips and lower back.

Starting Position

The Stretch

5.3.10 Harmstring Muscles

The hamstring is a bundle of muscles on the back of the upper leg. This group is the antagonist to the quadriceps, helping with flexion of the knee and hips. Just as with the quadriceps and iliopsoas, this muscle group spans two different joints and has a great influence on both the pelvis and lower spine. A well-stretched hamstring is essential for the flexibility needed in rock climbing. Also, an excessively tight hamstring can easily be injured and will likely cause long-term problem in your back and hips.

Starting Position

Overextend your right hip and place your left foot up on a bench. You may bend that knee, but keep your body erect and straight.

The Stretch

Slowly straighten the knee while giving it tension. You should feel the hamstring tightening up. Hold this position for 5 seconds, then relax. Do it again and hold it for up to 60 seconds.
IMPORTANT: Do not flex you lower back when doing this. To avoid flexing, slide your body forward rather than lean back.

Mistakes

Flexing the lumbar spine is not good during this stretch. Stay erect or bent forward.
Do not shift to one side or the other on your pelvis. Stay straight over your legs.
Fully extending the leg does not stretch the hamstring as well as flexing it to about 95% a straitened position.

Starting Position

The Stretch

5.4 The Strengthening of Weakened Muscle Groups

As athletes we need to remember that there are muscles that perform functions, and there are muscles that are generally used by the body to stabilize a joint. It is pretty common for us to train one muscle group well and allow other muscle groups to weaken. For instance, climbers usually have well developed shoulder muscles like the deltoids and latissimus, but the shoulder cuff muscles, which are mostly used to hold the shoulder "ball" in the "socket", are often over looked and not properly trained.

Another area we often fall short on in our training is the development of the antagonist muscles that are not regularly called upon in climbing. The most common examples of this are the extensor muscles of the forearms and the pectoralis muscles in the chest. Through our intense training of the flexor forearm muscles and our back muscles, we often leave these two groups relatively weak. This can result in elbow problems, like golfers elbow and tennis elbow, and bad posture (the hunchback).

As this book is focused on rock climbing, we will only discuss a few of these relative imbalances. For all of these exercises, the principle is to do three repetitions with a decent rest period of a few minutes in between. Fifteen to twenty repetitions of the exercise are usually recommended.

If you have reached the point of injury that you need to be looking up these exercises, you should have already been to the doctor. If not, go, and take this book with you and ask the doctor about the exercises.
A good physiotherapist can also help you personally tailor these exercises to your given ailment. Ask either the doctor or the therapist to help you with these exercises.

5.4.1 Forearm Extensor Muscles

Symptoms

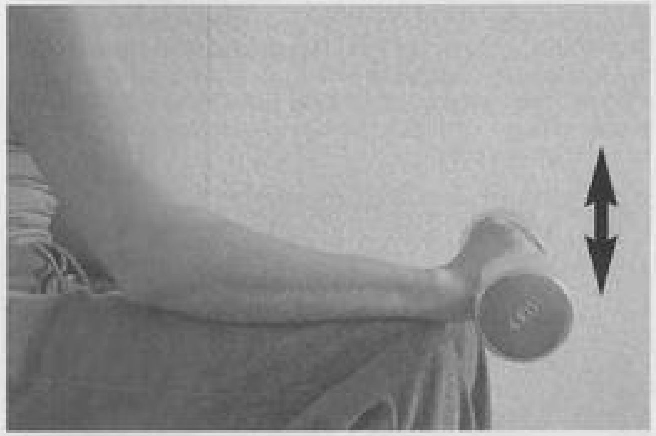
Underdevelopment of these muscles is very common, especially in young climbers and beginners who are seeing quick development of their forearms. Underdeveloped extensors usually lead to tendonitis in the forearm and especially in the elbow.

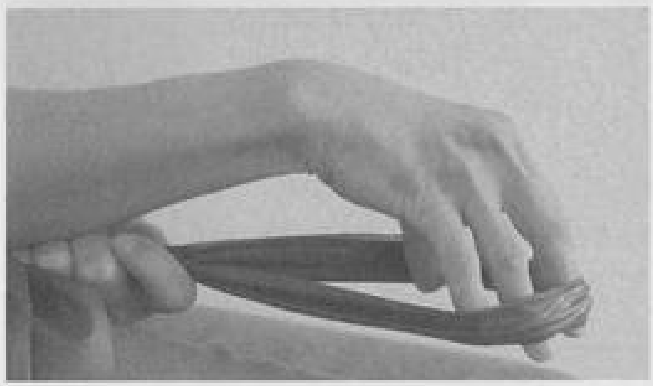
Exercise

There are three different ways we work to develop the extensors. The first is to sit on a bench and do reverse wrist curls over your knees with 2 – 12 pound weights. This works the muscles that extend the wrist. Next, get one of the many rubber band exercisers, like the Theraband (a strong rubber band works well too), and open your fingers against it.
Finally, rowing exercises will help you to keep the extensor muscles flexing in a way that opposes the work we do with our flexors when climbing.

Tip

Make sure when you start these exercises that you begin, no matter how strong of a climber you are, with lighter weights and more repetitions. Over-powering these muscles can bring on tendonitis.





5.4.2 Rotator Cuff Muscles

The four muscles that form the rotator cuff are the supra spinatus, the infra spinatus, the teres minor, and the sub scapularis. Together they are the most important stabilizers of the shoulder joint and are of critical importance to climbers who spend a lot of time on overhanging rock.

Symptoms

A dull ache in the shoulders after climbing is common when these muscles are underdeveloped. Some numbness in the hands is possible, and subluxations of the joint and chronic bursitis can become commonplace when there are advanced levels of underdevelopment.

Exercises

There are a number of exercises that your physiotherapist can show you. Lying down on your side and on a bench, then lifting lightweights by rotating your arms, is effective. We like to use a bungee or bicycle inner tube, as it increases the force the further you pull it (as opposed to weights which tend to change force due to the angle you are pulling at relative to gravities pull).

Starting Position

Notice that he holds his elbow against his body and simply pulls across his torso. For inward rotation (working the sub scapularis) simply turn around and face the other way, thus applying the pressure more intensely when the hand reaches the chest and not when it reaches away from the body.

Final Position

5.4.3 Scapula Stabilizing Muscles

Symptoms

The symptoms are Impingement Syndrome, which can be found in Chapter 3.

Exercise

Stand a few feet from a wall (enough so you have to lean just a little to make contact) and place your palm against it with your fingers pointing inward. Now lower the shoulder blades. Lean back away from the wall and hold this position for 30-45 seconds. Do 3 to 4 repetitions of this on both sides.

5.4.4 Stomach Muscles

The stomach muscles, working in combination with the back muscles, help to stabilize your body. Both of these muscle groups are frequently left untrained in top-level athletes, bringing on numerous medical problems. Also, most of the training of these muscles is done in static, uncomfortable positions, so it is often avoided. A lot of lower back pain could be eliminated by working these stabilizing muscles of the abdomen, but the regimen needs to be done in all of your training sessions and on all of your climbing days. Also, when you work the abdominal group, you need to work the lower back (and visa versa). The whole idea here is to not let one group get more powerful than the other!

In medicine, we see a lot of incorrect training methods employed by athletes to strengthen the lower back and stomach. Many of these exercises actually lead to the injuries the athletes are trying to prevent. As these muscle groups work to hold the back in a static position, they should be training in a static position.

The most effective way to train these muscles is to work the lower, upper, and diagonal muscles independently.

The stomach muscles, as the antagonists to the lower back muscles, are very important in training and for your all around health. One of the most effective ways to train them is by doing sit-ups and leg-ups without aid of the arms.

Exercises

The shown exercise will be modified (see below) for the different parts of the stomach muscle group. The correct starting position is to have the lumbar spine flat on the ground and the hands and arms lying next to the body.

– **Lower Abdominal Muscles:**
Lift the knees to 90 degree (as if pointing the knees at the ceiling) and hold the position for up to 20 seconds.

– **Upper Abdominal Muscles:**
Flex your knees and place your feet on a bench, then lift your upper body and hold the position for 20 seconds.

– **Diagonal Abdominal Muscles:**
Repeat the above exercise but rotate the body to the left in one exercise and the right in another.

If the exercise is performed while rotating the torso, the diagonal stomach muscles get a good workout.

5.4.5 Lower Back Muscles

This is an example of the bad training for lower back stability. Muscles used for holding you in a static position, in general, should not be trained dynamically. Also, this exercise places a lot of stress on the 5th lumbar vertebra and many of the inter-vertebral discs.

This is the correct stance to hold when working the lower back muscles.

Exercise

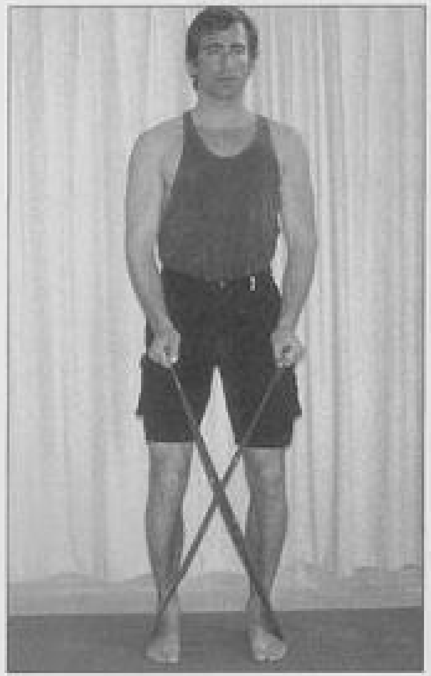
Drop onto your hands and knees. Straighten your back, then lift your left arm and right leg and hold the leg, body, and arm in a horizontal position for 30 – 40 seconds. Switch sides and do it again. Do this for 3 – 4 repetitions.

Exercise

Another exercise can be done with a Theraband, bungee cord, or old bicycle inner tube. Start standing with the cord fixed under the feet and crossing in front of the legs (see the photo on the opposite page). The band should run from the left foot to the right hand and the right foot to the left hand. Now lift the bands upward and sideways.

Mistake

Make sure your pelvis and lumbar spine are stabile and that you do not shift from side to side while you lift.

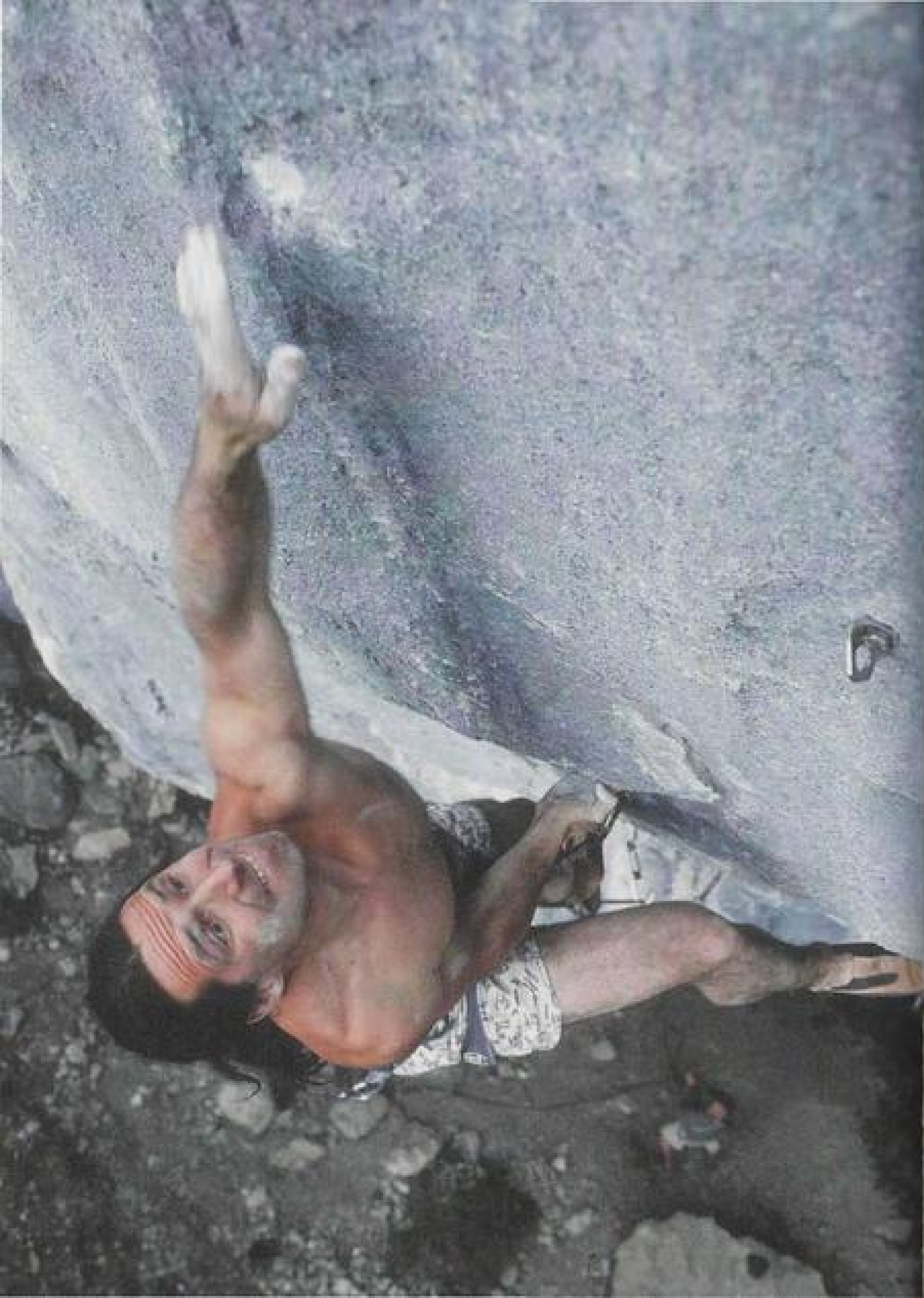


Starting Position

Final Position

Exercise

A final exercise can be done for both the back and the stomach. Lie on your stomach and simultaneously lift your hands and legs so they do not make contact with the ground. Now roll onto your back and do it from this position.



6. Rehabilitation after Injuries

Half of all sport climbers will have an injury to the fingers, hands, or arms that will require a long break from climbing. Only a few of those climbers will allow themselves to be in a physical therapy program for treatment, and even fewer are currently doing exercises that would prevent those injuries from happening in the first place.

Generally speaking, climbers tend to go back to training too soon after an injury. Returning to the sport before the injury has healed can cause excessive and irreversible scarring to the injured area that might lead to long-term problems (an example would be fingers that will not completely open after a pulley tear). If you want to see it for yourself, ask the next older climber you meet to set his hand completely flat on a table. There's a good chance his fingers will not straighten out completely, and a good chance he suffers from painful arthritis as well.

Injuries and overuse syndromes push athletes backwards in their development. A severe injury can push a climber back so far that he/she does not regain the same level of performance for 1 – 2 years. Another factor in timing your return after an injury is that the injury can very easily re-occur if the tissue has not fully recovered, thus setting you back even further. This puts off the necessary rest time and thus means you will need a longer recovery period to reach your full ability. Too early a return to climbing is common for climbers with injuries to the tendon sheaths or pulleys. The general stress one puts on their hands in an ordinary day is often bearable after only a few days, but the stress placed on the hands in climbing should not be attempted for weeks.

Overuse injuries can also affect areas near, but not at, the point of original injury. This is common in the tendons, which may be initially injured in just the finger, but continued use of that finger might allow the tendonitis to spread or create conditions that make a pulley rupture more likely. Again, the early stress of the injured area can exacerbate the problem or make it spread, and thus require more time for recovery.

◁ *Alexander Huber on "Lichtjahre" (8b+), Schleierwasserfälle/Austria*

The re-occurrence of injury is a problem all athletes face. A well-developed athlete who is forced to take some time off for recovery has to be especially careful not to re-injure the affected area. When coming back to training a well-conditioned athlete will regain strength in the muscle tissue faster than in the connective tissue. The fact is tendons and ligaments grow slower than muscle, but this is even more pronounced when the athlete is regaining strength he or she already had. When returning to the sport, and its associated training, your body will gain back the muscle it previously had much faster than it gained it initially, but the tendon strength will return at the original pace. We have found that the neuralgic region in the tendons, where the muscle condenses into the tendon, is the most likely to be injured in this phase of recovery.

The amount of time needed until you can return to climbing and training varies depending upon which structure is injured and the severity of the injury. However, with physical therapy and rest, the following times can be expected for a full recovery:

NOTE

Muscle Tear in the Forearm	2 to 4 weeks
Finger Fractures	2 months
Partial Pulley Tear and Tendon Sheath Ruptures	2 to 4 months
Collateral Ligament Tear (middle joint of finger)	2 to 4 months
Finger Fractures affecting the Joint	3 to 4 months
Tendon Strains	4 months or more
Complete Pulley Tear	3 to 6 months

When an injury occurs, or you come to recognize you are suffering from an overuse syndrome, the first steps in recovery may dramatically shorten your rehabilitation time. All rock climbers should know the acronym R.I.C.E, which stands for rest, ice, compression and elevation.

1. Rest

Pain is an alarm. It is a warning that something in the body has been damaged, and you should not ignore it. After any injury you should listen to pain and immediately rest. Keep in mind that the level of pain does not always reflect the severity

of an injury. For instance, a strain of the ligaments of the ankle is often more painful than a complete tear of those ligaments. This is because a strain stretches the pain receptors, while a complete tear actually severs the receptors thus keeping them from sending a pain signal. Often in a complete sever of ligaments the pain comes on later when the area begins to swell.

2. Ice

Invented over 4 billion years ago, this frozen combination of hydrogen and oxygen atoms has not yet been improved upon. You hear it mentioned every time there is an injury, or after surgery, and for good reason. The cooling effects of ice are as potent as any drug on the market at reducing swelling and blood flow. Following an injury, ice should be applied to an area as soon as possible. The ice, or so-called "coolpaks" (chemical derivatives of the same thing... cold), should be placed on the area for around 20 minutes. After removing it there will be an increase in blood flow, which can be remedied with compression (see below). Avoid placing the ice, or pack, directly on the area as it is easy to frost bite your skin. A thin towel placed between the ice and your skin will serve as a sufficient insulator while allowing the cool temperatures to penetrate. Icy water of about four degrees Celsius has proven to be the most effective temperature to safely cool an injury. An easy way to get water to this temperature is to use the "hot ice" technique. Placing ice cubes in hot water does this.

For chronic problems, icing for five to ten minutes has proven very effective. The increased blood flow (reactive hyperemia) following icing is actually the most effective part of the treatment. The drawing in of blood brings in the necessary nutrients for healing, so even the cooling sensation of placing rubbing alcohol on the area can have some benefit. However, alcohol tends to only work on the surface, but the cold of the ice can actually penetrate the tissue.

3. Compression

The use of compression is only necessary after an acute injury. After icing, the small blood vessels will dilate leading to an excessive flow of blood to the injury. This effect, reactive hyperemia, should be held back from an acute injury with compression. Without the compression the swelling can simply re-occur and the blood flow will be restricted again. Just as a point in fact, compression is recommended, but make sure you avoid constriction! It is possible to slow the healing by putting a compression bandage on so tight that it cuts off the blood flow.

4. Elevation
By elevation we mean the act of keeping the injured area above the level of the heart. Elevating the injured limb helps reduce swelling and increases the vascular out-flow from the injury to the central body.

Rehabilitation time is broken down into three steps, with the above R.I.C.E. being the starting point. During your recovery period the injured structure should first be healed to its original state. Once it is structurally sound the third phase, regaining its ability to handle severe stress, should be attempted.

THERAPY

Three Steps to Recovery:

1. Immediate Care	- RICE
2. Therapy Stage I	- Operation - Cast/splint/tape - Immobilization - A pause in climbing and training
3. Therapy Stage II	- Physical therapy (ultrasound, electrotherapy, ice therapy) - Physiotherapy (massages, active exercises) - Return to light training and easy climbing

In Therapy Stage I, the second step, the injured structures should regain their stability. Generally in this step the soft tissue needs to be immobilized so as to prevent the accumulation of scar tissue. The second stage, step 3, is defined with lots of physical and physiotherapy. These can be broken down as follows:

1. A period of stability exercise. This would be exercising with light weights just to get the area moving and working with slightly higher loads than what it experiences in day-to-day chores. An example would be slowly working up to putting your full body weight on both legs after suffering an ankle fracture.

2. A period of using the injured area in day-to-day life without feeling pain. Using the ankle example, this would be simply being able to walk without cringing from the pain felt when you first weighted the foot.

3. A period of placing the stresses on the injured region that is similar to your original training regime, but not as severe or difficult. With the ankle, perhaps this would be an easy hike.

4. This period is when you are back to normal and placing 100% of the original stress of training and climbing on the injured area.

When you get back to training, as in Period 4 of the above, the following steps should be run through:

NOTE

Step 1: you regain full range of motion
Step 2: you regain the power you had in the area
Step 3: you regain your coordination in that area

Experience shows that a lot of athletes, especially climbers, are neglecting a methodical approach to recovery and jumping forward in their steps. For example, they might go straight from being able to bear the pain of weighting a fractured ankle to going on a long arduous, mountain-approach, cringing their whole way up and down the trail as they near a climb. Giving their body time to adjust to day-to-day activity, and then doing some easy hiking, are crucial steps that help in many ways towards recovery. Simply enduring the pain is likely to bring on a relapse and perhaps, depending upon the injury, have long-term implications to your health. Remember, pain is an alarm. Ignoring it might have serious repercussions.

Recovering correctly, that is being patient and going through these steps, is one of the hardest things to do. Nine times out of ten that injury is going to occur when you are feeling great and have a project or some big climb planned for the near future. The fact is a break from the sport is necessary with an injury.

Untreated injuries can cause pain for up to six months or more, and symptoms related to the injury can last for years, perhaps never allowing a full recovery of your previous abilities. Knowing that years could be lost if you don't take a rest, its obvious that it's best to simply take the prescribed break and go through the therapy.

6.1 Practical Tips

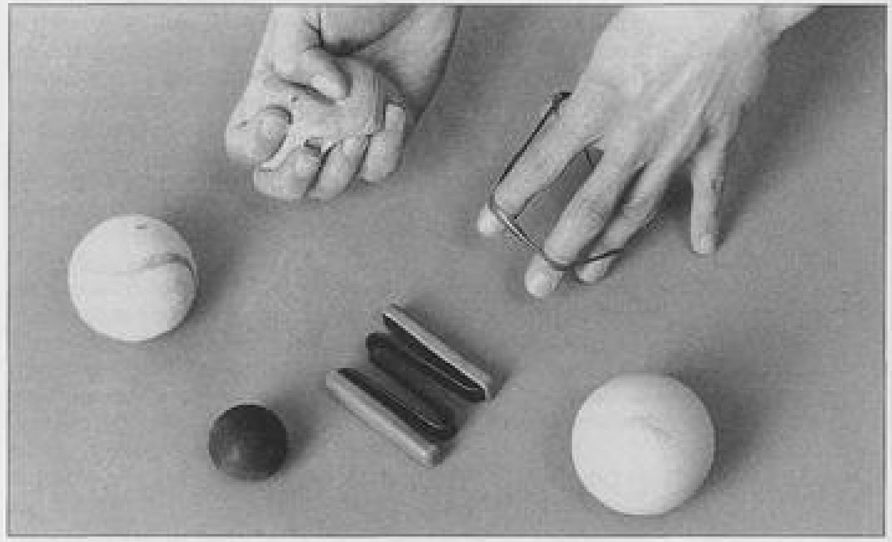
After you have immobilized the injured area for the proscribed period, it is time to regain the your original range of motion. Usually this is not too much of a problem. For fingers, a good way to begin is to warm them up by doing the first motions in a tepid bath. Special physiotherapy exercises will help to regain the motion back. You will be doing most of the work, even if a therapist helps at first, as this is something that needs to be repeated constantly. Stretching exercises for the flexor and extensor muscles should be performed three or four times a day.

You should not, under any circumstances, begin power training until you have regained your full range of motion. Using the hands as an example, developing power when the fingers are still rigid and stiff could easily bind them in that position and give you a lifetime of inflexible fingers and potential problems.

After your full range of motion is reached and you are nearly symptom free, a routine of easy training can be started. Items like a Theraband, trainer, soft, squeezable balls, or maybe some malleable putty like Play Dough, can be used to exercise the muscle while not putting too much strain on the connections.

Using these types of hand exercisers helps the fingers in a number of ways. One is that they increase blood flow through massage. The chronic swelling of the tissue that is associated with the injury is reduced by kneading the tissue, just as a masseuse would do. Also, the cartilage is given its necessary nutrition by working the fluids around inside the joint capsules, and the muscles are given a faster rate of blood flow through their flexing and relaxing. This in turn helps to reduce the increases of synovial liquid inside the joint and scar tissue that would otherwise impede future development of power.

Next you can move on to hand training devices that increase both power and coordination. A number of gripping devices, like the Mastergrip, Maxi Grip, and the Busy Hand, as well as just squeezing a tennis ball, help to increase power while not putting the intense pressures associated with climbing on the connective tissues. Qi-Gong Balls can also be used to increase coordination and flexibility.



After a period of immobilization the full range of motion should be regained. Easy training can be done with any number of soft, spongy, toys like balls, rubber bands, and other hand exercisers.

Again, the regeneration of healthy tissue after an overuse syndrome is facilitated by blood flow. The better the blood flow, the more nutrients can be brought in to heal the affected area. The easiest way to increase blood flow is through the application of ice. Initially, when ice is applied, the cold temperature constricts the blood vessels forcing out any blood that had been slowly moving through the region. This constriction is followed with a reflexive response, that being an excessive dilation of the blood vessels and thus a greatly increased volume of blood-flow. If suffering from an acute injury, it is very important here to remember the "C" in "RICE", that being for "compression". You will need to compress the area so that the blood can flow and not surge into the area and then stagnate again, then causing an even greater amount of swelling. Again, the so called "hot ice", that being the use of ice cubes partially melted in a bag of water, is the most effective way of reducing the swelling.

For the best results, the ice should be administered for roughly 20 minutes. Ice itself should never be placed directly on the skin as frostbite, especially in thin areas with limited blood flow, can be brought on in little time. The widely sold cold-packs are easier to use than filling plastic bags with water and ice, but they are just as likely to create frost bite, if not more so, than true ice. Ice lolly-pops, ice cubes with tooth picks frozen in them, are an easy to use applicator of the cooling effects of ice. Also, paper cups filled with water and kept in the freezer make great blocks of ice for larger areas of injury. One important point to remember: make sure when applying any of these cold treatments that you place a thin cloth or t-shirt between your skin and the bag, pack, or ice block. It is very easy to freeze the skin or the tissue under it, thus adding another level to your injury. Ice therapy can be done three to five times per day.

Another means of increasing blood flow is by brushing the area. Lightly rubbing the injured area with a toothbrush or similar soft brush stimulates the surface and thus greatly increases the blood taken to the region. This is especially effective in inflammations of the tendon sheaths that are near the surface.

In the initial stages of an injury, the application of ice is usually more effective at increasing blood flow. However, the application of heat rather than ice is prescribed more often the more chronic the injury is. That is to say, if you have had tendonitis in your fingers for years, heat will probably be more effective at increasing blood flow than ice will. There are various ways to apply heat. Warm sulfur baths can be a very effective way to increase blood flow to a region. However, the sulfur, though useful as an anti-inflammatory, can irritate the skin. One needs to monitor how much sulfur their skin can handle and not do this treatment more than three times a week (once or twice a day can be prescribed in the most serious cases). Hot towels can also be effective, and bags of heated sand, just as bags of icy water, are good for holding heat on an area for long periods of time. Again, just as in the application of ice, one needs to be wary of damaging the skin.

The application of heat is generally more useful in osteoarthritis and overuse syndromes in the muscles. It works in the fingers as well, but there is no definitive injury that will react better to heat or better to cold. Finding out which is more ef-

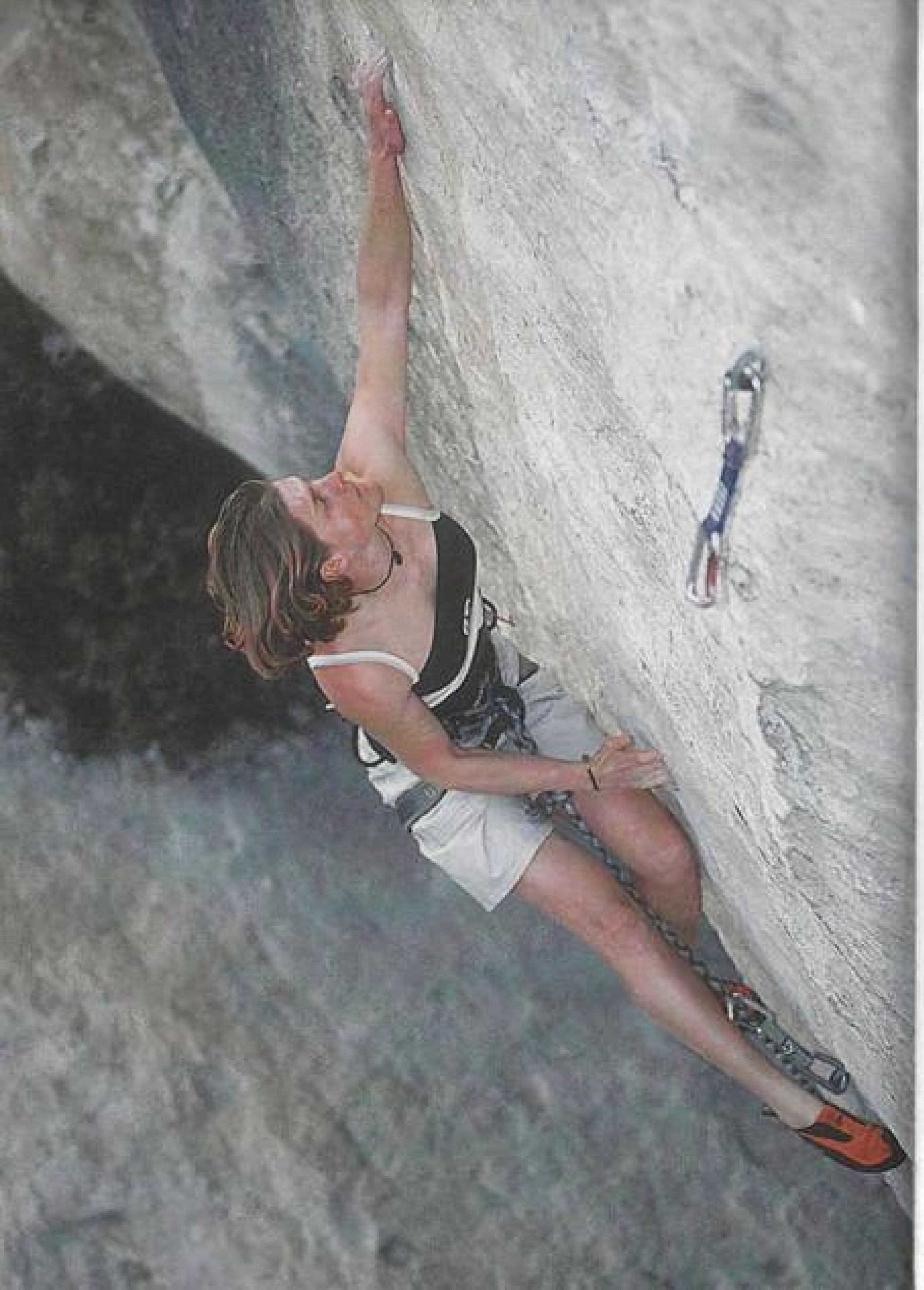
fective is a function of who is receiving the treatment and not what the treatment is for. Some people react better to heat, others to cold, and the only way to find out how your injury will do is to try both. Make sure you follow the guidelines when doing so.

All these physical and therapeutically remedies can be increased with the oral intake of NSAD (non steroidal antiphlogistic drugs) such as ibuprofen, diclofenac, celecoxib, etc. Keep in mind that medication should not be used just to overcome the pain of rehabilitation. The pain is there to help you monitor the stress that is being placed on the joint and to keep you from "over-doing it". These drugs are used to reduce swelling and inflammation and you need to be off them before you start training again.

When you begin climbing again, you should focus on longer routes with big holds and not on shorter, bouldery, climbs. Your initial aim should be to regain the coordination of the movement as well as the necessary endurance needed in the sport. Training on the campus board and hard crimping on small holds is likely to bring the injury back. This is especially the case with pulley injuries, which require at least 12 weeks of rest prior to any hard crimping.

Post Therapy

To increase blood flow:	Ice Hot/cold alternating baths Massage using a brush Electro-therapy Soft balls and other hand exercisers
To decrease inflammation:	Ointment dressings Sprays with non-steroidal Anti-inflammatory drugs Heat packs of sand Sulfur baths
Muscle Development:	Therapy work Hand exercisers
Coordination Training:	Qi-Gong Balls



7. Taping

Taping the fingers and hands for crack climbing has long been commonplace to prevent skin injuries. Professional boxers, football players, and basketball players all use tape to prevent injuries and to allow them to participate in the sport when recovering from an injury. Taping can allow an athlete to work at his/her sport with some protection while not completely immobilizing the injured area as a cast would. However, to use tape correctly, a proper diagnosis of the problem is required and the correct application of the tape is an absolute necessity.

Taping around a previously injured area is often done as a form of functional therapy. Many of the procedures we use for treating an injury can also be used to prevent that same injury or to help you to recover after it. Taping the fingers, the wrists, and the muscle insertion points in the elbows, can work as prophylactics against injuries and to help you recover following an injury.

As it does for other athletes, taping works for climbers in two ways: it can be a prophylactic and it can be therapuetic. The bulk of this chapter deals with therapeutic taping, that is taping an area because of an overuse syndrome or when returning to climbing following an injury. You will find specific uses of tape for various problematic areas further down.

Prophylacitic taping of the hands and fingers for crack climbing can help prevent skin tears that can be so painful, or so bloody, that they inhibit climbing. Prophylactic taping can also protect the fingers when pocket climbing, and in both instances the tape is simply applied to the spot that makes contact with the rock. However, taping as a prophylactic for structural injuries inside the fingers and hands is not something that should be done regularly. The injuries that can happen to joint capsules and ligaments can sometimes be prevented with tape, but the preventative effects of the tape might also stop the body from strengthening those tissues.

◁ *Nicola Haager on "Chouca" (8a+), Buoux/France*

The long term effect is that those tissues will not develop the strength that climbing requires and will, eventually, become problematic. It is therefore important that the stresses of climbing be dealt with by the body as much as possible so that the tissues can adapt. Therefore, we do not recommend regular prophylactic taping for structural injuries.

When do you tape your fingers? Most of the injuries and overuse syndromes you will suffer in the fingers can be aided in their recovery through taping. After a pulley rupture you should tape for at least three months, with the more severe ruptures requiring up to 12 months of taping. With tendovaginitis you should also tape as the tape helps to spread the pressure of the tendon on the tendon sheath more evenly and thus help the healing process.

Important Notice

Never pull your tape straight from the roll onto the injured appendage. To tape correctly, you should tear off a strip of tape at the desired length and then gingerly apply it to the injured area. Taping your injury straight from the roll usually makes the application too tight.

7.1 Therapeutic Taping for Pulley Support

As stated in some of the previous chapters, stress on the finger flexor tendons when climbing is severe, and it is especially so at the base phalanx. Around this bone is where we see many of the injuries and overuse syndromes that are dealt with previously, including A2 pulley tears, tendon ruptures, and tendovaginitis. If you have been diagnosed with a pulley injury, it makes sense to tape the area to prevent further injury and to allow the pulley to heal while being stressed.

Taping the joints for pulley support is some what contradictory to how most trainers would tape athletes. Generally speaking, you do not want to wrap tape in a complete circle around an appendage as it might cut off some of the blood flow and actually cause another injury. However, 2 1/2 layers of 8 to 10 mm wide tape, wrapped in loops around the finger, have been shown in experiments to have about 50 kg of

strength. This just so happens to be about the tearing force required for an A2 pulley rupture. If the tape is not in complete loops around the finger, it does not have the required strength. However, we cannot stress enough just how important it is that you do not tape too tight. Cutting off circulation to the point that there is swelling or discoloration in the finger can make the injury worse. Make sure you put the tape on loose enough to allow blood flow. Also, make sure you use 8-10mm wide strips of tape. Tape strips that are thinner than 8mm are not wide enough to properly spread the stress and are thus more likely to cause circulation problems or even nerve damage. Tape that is over 10 mm in width can inhibit movement and is an excessive amount of material for attaining the desired effect.

Above: Tape rings to protect the A2 pulley and the connective tissues at the base phalanx.

Below: Tape to protect the A2 pulley on the ringfinger, the tape on the middlefinger protects the A2,A3 and A4 pulley.

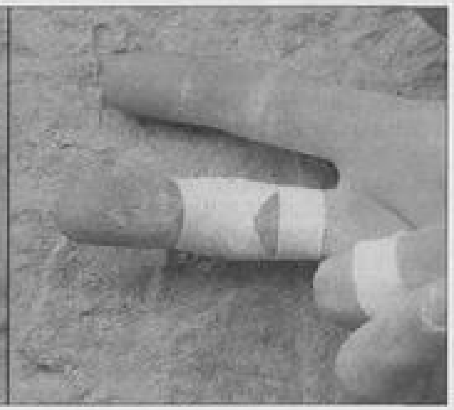
There are two ways to effectively tape the pulley. The first is to tape just the base phalanx so that the A2 is effectively held by the tape ring. To do this, rip the tape in roughly 8 to 10 mm strips and run it around the base joint in two or three wraps. This is a fairly small amount of tape to get used to climbing with and will help when you are suffering from tendovaginitis or a pulley strain close to the palm.

However, it is not as effective as the figure-of-eight method for supporting the connective tissues of the finger. To do the figure-of-eight method, make your first wrap of tape on the base phalanx near the joint between it and the middle phalanx. Wrap twice, then pull the tape to the middle joint and wrap two times. Pull it back and make one wrap over the previous two wraps on the base phalanx. While pulling the tape from one phalanx to the other give your fingers a slight bend, maybe 30 degrees, to make sure you have full mobility. If the tape is put on incorrectly or too tight, it will be hard to bend the fingers.

This is an example of taping for the entire pulley system. This method is known as the figure-of-eight.

The figure-of-eight is the recommended method for taping when you are recovering from a complete pulley rupture as it supports the A2, A3, and A4 pulleys. Simply wrapping the A2 gives it good support, but allows more stress to fall onto the other pulleys and thus puts them in a more likely position to be injured. Also, this method tends to hold up better through a day of climbing. Keep in mind that having that much tape on you fingers can make it difficult to get them into tight pockets and finger locks and can take a while to get used to.

This is an example of taping for the entire pulley system. This method is known as the figure-of-eight.
Make your first wrap of tape on the base phalanx near the joint between it and the middle phalanx.
Wrap twice, then pull the tape to the middle joint and wrap two times.
Pull it back and make one wrap over the previous two wraps on the base phalanx.



7.2 Therapeutic Taping for the Finger Middle Joint

An injury or overuse syndrome in just the middle joint of a finger is more difficult to tape for as it is difficult to tape and still get decent mobility in the joints. The figure-of-eight works well, but it is important to make sure you get a 30 – 40 degree amount of flexion in the joint while administering the tape. The difficult part of this is making sure that the finger flexion and extension are both easily done while making the tape tight enough to give support to the underlying structures. You may have to apply the tape a few times during the day. By the way, this method of taping is good for supporting the finger when it is used in a mono-pocket.

Circular tape with "side-stripes" helps protect the collateral ligaments in the joint.

When you are protecting an injury to the collateral ligament in a finger, the tape needs to run over that ligament so as to give it direct support. The collateral ligament runs along the side of the joint, so the best methods of taping are either to use the figure-of-eight method, letting the crossing point be on the side of the finger instead of the palm, or run a strap of tape under separate rings on each phalanx. The latter takes a bit longer to put on, but may perhaps give more support after you have been climbing a while.

7.3 Therapeutic Taping for the Finger End Joint

Unless you have the hands of Shaquille O'Neil, therapuetic taping of the last phalanx of the fingers is hard too do. The area is just too small to hold tape while still allowing you to move the finger effectively or allow the pad on the finger to hold onto edges without creating a slick layer of tape. If you must tape this joint, the only practical method is to make one or two wraps of 8 – 10mm tape on the actual joint.

7.4 Taping for Tendovaginitis

Taping works as therapeutic support when climbing while recovering from tendovaginitis. The swelling associated with tendovaginitis is exacerbated by the stress placed on the tendon where it runs past the A2 pulley. If that stress can be spread over a larger area, say the width of a strip of tape, then the given stress will likely be less on the injured area. As tendovaginitis requires a long recovery period, you will not notice immediate relief from the pain. You might find that you need to tape for 6 weeks or more so that the tendons have a chance to completely heal while they are given the support. Since most cases of tendovaginitis in the fingers occur near the A2 pulley, 3 wraps of 8 to 10 mm wide tape on the base phalanx are usually enough to give the necessary support.

7.5 Taping the Palm

Overuse syndromes in the palm, such as tendovaginitis or trouble with the A1 ligament, can be helped with a wrapping of the palm. This is done in the same manner as taping in the phalanxes, but placed across the widest part of the palm. In this case, use a strip of tape roughly 1.5 cm wide.

A circular wrapping of tape on the palm can help with some overuse syndromes in the hand.

7.6 Taping the Wrist Joint

When underclinging or holding onto side-pulls, the flexor tendons are under a lot of stress where they run through the wrist joint and past the Retinaculum flexorum ligament (in the carpal tunnel). The pain can be so severe that underclinging cannot be done. A 2.5 cm wide band of tape can spread out a lot of the load the tendons are put under in the tunnel. To do this correctly the tape should be put on in two parts so that each can overlap the other. This allows the tape to be tight but to shift and therefore allow better blood flow relative to the tightness. To do this, place a strip of tape about 2/3 the way around the wrist. After this application, tear off another piece of tape of the same length and wrap the wrist in the opposite direction. To make the tape stay on longer, it is good to make sure the second wrapping covers the outer edges of the first

Tape around the wrist can help to spread the load on the tendons when underclinging and holding onto side-pulls.

7.7 Taping the Elbows

Taping the elbow works as prophylactic therapy for epicondylitis. There are two methods for taping the elbow, either of which is chosen depending which condition you are suffering from and which taping method is more comfortable to you. For epicondylitis of the extensors, the best method (though the second method works for it as well) is to place strips of tape running just over half way around the arm on both the flexor and extensor sides.

Taping of the forearm for epicondylitis

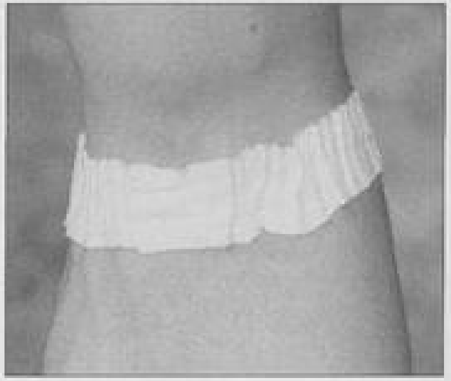
Make the strips roughly 3 cm in width and place them so they can overlap each other. Having strips of tape that overlap each other allows for some flexing of the tape as your arm gets pumped. Keep in mind that this application of tape should be supporting both the muscle and the muscles insertion point. Unfortunately taping here can have one big disadvantage, that being that the tape is on too tight and thus putting pressure on the veins that drain the arm. This can cause a back flow of blood into the arm and increase your pump. It is likely that you will need to apply the tape a few times before you find the balance point between tape with good support and tape that is too tight.

For medial epicondylitis of the flexors we have seen the best tape results from tape applied around the arm just above where the pain in the epicondyle is most pronounced. Take a 2 to 2.5 cm strip of tape and wrap it around your arm just above the elbow and over the biceps tendon. Make sure your arm is bent at about 90 degrees when you do this and that the biceps is flexed. By flexing and bending the arm you will be sure to not put the tape on too tight. You will notice that when you relax the arm the tape adheres to the arm with small folds. When the arm flexes and the muscles swells, these folds will be taken out and the tape will be just tight enough to give its support. If you have done this correctly there should be no increase in pump or back flow of blood.

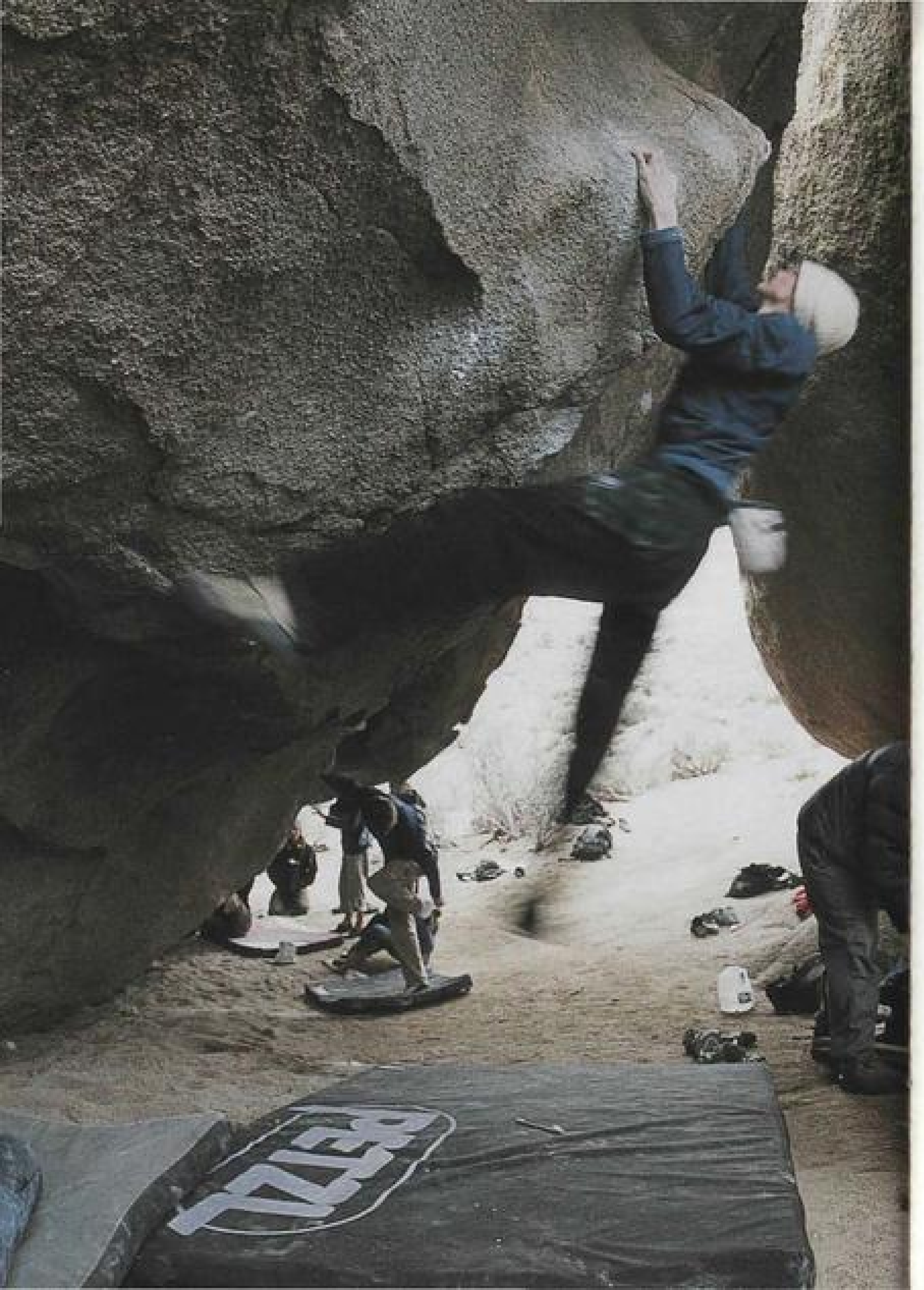
Above:
Notice the folds of the tape
Lateral view of the ellbowtape without muscle tension, the tape shows folds.

Below:
If the muscles get tension the tape gives little way, so no compression takes place and you won't get pumped

The condition known as climbers elbow, that being inflammation in the elbow of the brachialis, is difficult to tape for. The position of the inflamed muscle and connective tissue is too deep inside the arm to use tape for structural support. Never the less, we have seen some positive results with the use of tape when suffering from the condition. It is not clearly understood, but it appears that the above mentioned ways of taping give some indirect support simply by supporting the other structures. Also, it is thought that the sensation of the tape "reminds" the brain of the injury and it in turn tries to accelerate the healing processes of the body. That sounds a little funny, but as we said it is not clearly understood. Again, we the authors, as well as most of our friends, have suffered from climbers elbow and we have all gotten some relief, though not structural, from taping.



Notice the folds of the tape



8. A Few Points about Nutrition and Climbing

Your diet is one of the most important factors in determining your productivity as a climber. On top of that, there is probably no single factor that has a greater influence on your long-term health than your diet. Though numerous books and articles have been written about intense training for athletics, very little has been laid out for athletes on nutrition. The uncertainty over what is good and what is bad for us has given rise to an entire industry of supplements that promise the world but often deliver very little. The intention of this chapter is to give you a few facts about nutrition and let you know what is needed, as well as a few things that are unnecessary, in your training and climbing program.

8.1 Nothing Happens without Carbohydrates!

Carbohydrates are the body's favorite energy source and are indispensable for any intensive workout. Carbohydrates are easily synthesized into glycogen which is required as the main fuel source for your muscles. The nervous system is also fueled by carbohydrates, and red blood cells require them in the form of dextrose.

Obviously, it is important that you maintain a sufficient level of carbohydrates in your body at all times. For this reason, the body stores carbohydrates in the liver as glycogen, but on average this stored supply is roughly 1200 – 2000 kilocalories and will last no more than 90 minutes in an intensive workout. If the body exhausts all of its stored carbohydrates, it will begin to synthesize glucose on its own by metabolizing muscle and blood plasma. That's right! An under-fueled body will cannibalize itself. Technically, this cannibalizing of muscle is referred to as the catabolic condition. If you stay in a catabolic condition for long periods, as a person with severe eating disorders does, it will change your recovery times (for

◁ *Bouldering at Bishop/USA*

the worse) and will eventually start weakening the very muscles that you are training. Obviously it is prudent to eat plenty of carbohydrates, and the longer and more intense your workout, the more "carbs" you need to eat.

Carbohydrates can be broken down in to two categories: simple and complex. Simple carbohydrates are in a form that makes them easily picked up in the blood stream. This is often what you need during long spells of exercise, but not what you want to "fill your tank" before exercise. Complex carbohydrates can be used quickly as fuel, but can also be stored in the liver as glycogen and used later as fuel. This generally makes them a better supplier of energy. The best sources of complex carbohydrates are grains (breads, cereal, and pasta), vegetables, rice and potatoes. These foods also tend to be low in saturated fat and good sources of vitamins. Potatoes, for example, are rich in minerals and so full of vitamin C that they could be called the lemon of the north. Other "leafy-green" vegetables are rich in the so-called antioxidant vitamins (vitamins A, C, and E) and have secondary substances that contribute to good health like glucosinolate, indole, isothyocianate, and falvanoide. Green vegetables tend to have a very low caloric value relative to the amount of vitamins and minerals they carry, so large amounts of them can be consumed while you still maintain a healthy weight.

NOTE

Carbohydrates

- Carbohydrates are the body's favorite source of energy
- Carbohydrates can be broken down into two categories: simple and complex
- A deficiency in carbohydrates can lead to "cannibalization"

8.2 Protein: You can only burn what you just took in!

Protein is an important building block for muscle tissue (and virtually every other tissue), but it is also used as an energy provider. While the body is able to store fats and carbohydrates to burn for energy, it has no means of storing protein. Practically speaking, every bit of protein in your body is serving a purpose, so it cannot be used as a fuel without doing some harm somewhere (your immune system, muscles, connective tissues, etc.). This means you must take in protein at the same level (or more) that you burn it or you will damage some part of the body during exercise. At a minimum, your diet should be 10 – 15% protein to cover your needs. A higher caloric burn rate means you should be consuming a larger number of calories, but keeping the percentages of carbohydrates, fats, and proteins, the same. If your diet is correctly balanced in this way, you will not suffer from a protein deficiency.

NOTE

Proteins

- Protein is an essential component for building muscle
- There is no storage unit in the body for protein
- Your diet should be at least 10 - 15% protein

8.3 Fat! The bad part of your diet?

The various types of fat perform some essential functions in the body and are especially important in athletes. Fats are the delivery system for fat-soluble vitamins, such as vitamins A and E, and are an important component in the body's cell walls. Fat patterns in the cell walls vary depending on the type of fat you consume and the type of fats each particular cell would prefer to be composed of. For this reason, we recommend fat bewell represented in an athletes diet, with 2/3 unsaturated and 1/3 being saturated.

Less saturated fat would be better, but getting this percentage below 1/3 is difficult to do with our modern diets. Non-athletes and people with a weight problem should probably consume less fat, especially the saturated fat. You should talk to a nutritionist about your specific needs.

The unsaturated fats improve the functioning of the cell membranes and help the red blood cells transport oxygen. Studies have shown that the so called Omega 3 fatty acids, those which are commonly found in seafood, improve blood flow and thus help lower inflammation. It then follows that they lower the risk of injuries and the overuse syndromes that we climbers suffer from. To back this up, studies have shown that athletes with extremely low intakes of fat are more susceptible to injuries, and we have found that tendon strains and tears seem to be more common in extremely lean climbers!

Your intake of unsaturated fats and fats low in cholesterol should be where you get this important component of your diet. It's important to eliminate the so-called bad fats and keep the good ones. Sixty percent of the fat intake of a western person is through such things as fried foods, butter products, and meat. The fat content of meat generally ranges from 15% in turkey to 75% in pork. Meat products, as well as milk based dairy products, generally consist of protein and fat and contain almost no carbohydrates. Climbers tend to be aware of fried foods as a source of bad fat, but they often ignore the fat intake that comes with dairy and baked goods. Make yourself aware of these sources of fat by reading the nutrition labels. Some dairy products, like sour cream and whipping cream, can be over 90% saturated fat. Pasta dishes can also sneak up on you with the use of heavy creams. Baked goods are often a good source of quick burning carbs, but they can hold a lot of fat as well from such baking basics as butter and oil. By keeping these fats low but still allowing yourself certain things like olive oil, you will lower your fat intake but still keep a healthy level of fat in your diet.

NOTE

Fat

- Fat is essential for the body
- Fat helps deliver fat soluble vitamins
- Fat can be broken down into two major groups: saturated and unsaturated
- Unsaturated fats are good for you
- Saturated fats are bad for you
- Athletes with extremely low intakes of fat are more susceptible to injuries
- Fats are hidden in a lot of our processed foods

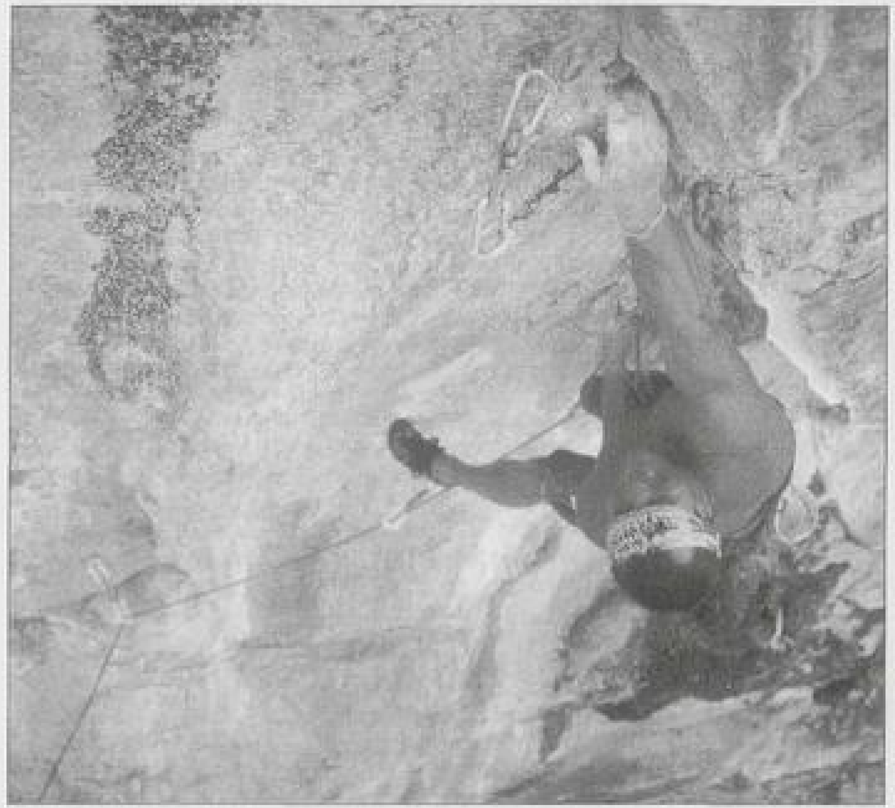
8.4 Malnutrition

If there is one principle that cannot be ignored in your nutrition, it is this: The body of a climber, just as with all other high

performance athletes, requires the intake of enough calories to cover the energy expended during exercise. In other words, if you burn 3000 calories in a day, you better take in 3000 calories as well. If you do not obey this principle, you will have problems holding onto a high level of performance and may suffer malnutrition diseases.

It is known that a high strength to weight ratio is important if you want to climb at a high level. For this reason, some climbers try to reduce their caloric intake (diet) to lower their weight. This is generally a no-no for a fit person. The fact is, a lower body fat level, and therefore a higher strength to weight ration, can be achieved by simply taking in more carbohydrates and avoiding the bad fats that are common in our diets.

Carsten Seidel on "No More Sunrise" (8a), Koh Tabang/Thailand



8.5 Supermodels Can't Climb!

The average American is fat. As if a walk through any American airport isn't enough visual proof, that fact is brought to light in study after study and is made apparent everywhere from the nightly television news to the daily paper. That said, the average climber is not fat. As a matter of fact, many of the climbers who are pushing the limits in our sport are potentially too thin. In 1987 the US Olympic Committee found that the average percent of body fat for a healthy athletic male was 14 – 16% and 20 – 22% for an athletic female, but we have found that number is way off what an avid climber performs at. Using the men as an example (the numbers for the women were similar), we broke down our study according to the difficulty level the climbers were capable of. The range was something like this:

5.12b to 5.13a averaged 11.4% body fat
5.13b to 5.13c averaged 4.9% body fat
5.13d and above was also at 4.9% body fat

Considering that the Olympians are averaging about three times that, these results are a bit alarming. It's downright scary when you know that some men in the test were actually below 2% body fat. A 1996 study of the German junior team found adolescent boys at 6.6% and the girls to have been at 8.9% when they should have been well over double that. These kids were merely following a trend that is set by the older and better climbers, but they were so lean that a few of them were suffering from iron deficiency.

Strength to weight ratio is important in climbing, perhaps more so than any other sport, but a University of New Mexico Study on climbers in 1999 showed that body fat below 6% for men and 10% for women does not significantly improve performance. As a matter of fact, it usually means you are operating slightly dehydrated and are burning some muscle while climbing, so it actually hurts your performance. Without that fat, you are starving your muscles and connective tissues of water and their necessary nutrition.

The quest for a high strength to weight ratio has actually made climbers one of the few groups of athletes that commonly suffer from eating disorders. Anorexia and bulimia are not uncommon, and numerous competition climbers have been known to take laxatives and diuretics. Because the culture of climbing has become so accepting of the "thin look", there is not much peer pressure to support someone who is feeling sick from malnutrition's ill effects. Often the body's reactions to eating disorders (lower levels of performance, depression, fatigue) help to promote the climber to push even harder in training and eat even less. It's a vicious cycle, and if it is not stopped it will eventually kill you.

Again, the end result of this obsessive behavior is not what you are looking for. Over time, an anorexic or bulimic climber will suffer a loss of muscle mass and a breakdown of bone tissue. There will be some hormone dysfunction (usually first noticed through a lack of menstruation or drop in sex drive), and they will suffer more infections and thus get to train less. Premature osteoporosis often becomes visible, and some climbers have even suffered from chronic fatigue syndrome for years after having stopped this behavior. All of this does not come on when the climbers are old and have quit climbing. It comes on right away, and it will actually make you old.

And parents... watch your kids. They are particularly susceptible to the peer pressure that can bring this on. The long-term ill effects of chronic malnutrition and eating disorders could significantly shorten their lives.

The Austrian Sport Climbing Association has already had to react to this alarming trend. To enter into a nationally sanctioned competition in Austria, a climber must have his/her body mass index checked and a certain level of fat relative to the person's size must be present (the figure is not reached simply as a percentage of body fat but also incorporates height). If you aren't big enough, you can't compete. So, eat a sandwich or something. There is no sense in starving!

- Supermodels can't climb hard
- Thin climbers suffer more injuries and infections
- On average, a body-fat level below 6.5% in men does not show any sign of improved ability
- You should watch for signs of bulimia and anorexia in your friends and kids

NOTE

8.6 Are Dietary Supplements Necessary for Good Health?

Even if you consume a diet high in fresh vegetable s and fruit, it is possible that you will not get enough vitamins and minerals to maintain good long-term health. According to Doctor Kenneth H. Cooper and the nutritionists at the Cooper Clinic in Dallas, the average person needs to consume something on the order of 5 – 7 servings of vegetables and fruit a day to get the necessary amount of vitamins and minerals. An athlete training at his or her peak needs even more. Very few of us eat that much fruit and leafy green vegetables, and what's worse, those that we do eat are perhaps not as vitamin rich as they once were. Some studies have shown that the modern ways of producing produce has created vegetables and fruit with lower concentrations of vitamins and minerals.

Intense exercise can cause a shortage of minerals such as iron, magnesium, zinc, and copper. Perhaps most important when considering the need for dietary supplements is remembering that intense exercise creates large quantities of so-called "free radicals" that can damage tissues. Free radicals can aggressively oxidize the fats that make up much of your cells' walls. Not only does this tend to age many of your internal organs and lead to long term health problems like cancer, but it also leads to a breakdown of cells in your muscles and connective tissues and can increase your chances of suffering some of the inflammations that climbers commonly deal with. Research conducted scientists from the Cooper Research Institute has shown that the correct antioxidant combination can actually reduce inflammation.

Studies have shown that certain vitamins, like vitamins A, B, C, and E, help remove free radicals from your system and heal the damage done by them to your cell walls. Athletes who train intensively for long periods of time should consult with a dietician or doctor about adding supplements to their diet (Keep in mind this information on supplementation is new and, at least in the United States, only 6% of the M.D.'s took a nutrition course in med school). However, remember that not just any supplement is going to help you deal with the effects of free radicals. The dietary supplement industry is rife with products that are ineffective for a variety of reasons. We recommend that if you are going to take these supplements, you should do some research and find the products that have been created by doctors and nutritionists. The processes used to correctly create and extract the vitamins and then put them into a form that is usable by the human body can be expensive and difficult. Just buying the cheapest thing available from the local grocery store will probably not be very beneficial.

Dietary Supplements

- On average it is difficult to get enough vitamins through our modern diets
- Certain vitamins catch free-radicals and thus improve long-term health
- Vitamin supplementation may be necessary, but know what your taking
- Glucosamine and Chondroitin may help with osteoarthritis
- Creatine has a very limited use in climbing
- Caffeine drugs are considered a form of doping by the IOC, but a cup of coffee is not

NOTE

8.6.1 Glucosamine and Chondroitin

As stated in Chapter 3, we climbers are probably susceptible to osteoarthritis in our hands. If you do a lot of long approaches or alpine climbing, or if you do a lot of drop-knee moves when sport climbing, then your knees are taking quite a beating as well. In the last few years glucosamine (glucosamine sulfate) and chondroitin (chondroitin sulfate)have become all the rage in helping people deal with osteoarthritis in the knees, hips, and hands.

The long-term studies are still out, but so far these supplements appear to be at least as helpful as non-steroidal anti-inflammatory drugs (NSAD's) at helping deal with the discomfort of osteoarthritis. Glucosamine has been shown in test tube experiments to stimulate the growth of new cartilage cells (*Data was taken from Food and Fitness Advisor, February, 2001*).

Water is very important in the correct function of the cartilage, and glucosamine has been shown to help hold water in the cartilage matrix. A 1999 experiment using two groups, one taking 1500 mg a day of glucosamine sulfate and another on a placebo, showed a significant improvement in symptoms (pain) for the glucosamine group and associated radiographs indicated a growth in cartilage. Another eight week double-blind study showed that after four weeks glucosamine was as effective at helping people deal with arthritic pain as 400 mg of ibuprofen (the standard NSAD) and even more effective than ibuprofen after eight weeks (*Data was taken from Alternative Medicine Alert, November, 1998*).

Chondroitin is a long chain amino sugar that exists naturally in cartilage. Chondroitin as a supplement has been shown to improve the viscosity in the joints and seems to work as an anti-inflammatory (*Data taken from the Cooper Center's information page on Glucosamine and Chondroitin*).

Like glucosamine, it also helps promote water retention in the cartilage and thus improves the tissues shock absorption. On top of that, it seems to inhibit the enzymes that break down cartilage and thus give the existing tissue a longer lease on life. The effects of glucosamine and chondroitin seem to be amplified when they are taken together, so it is common for the two to be combined as one supplement.

While glucosamine and chondroitin have been shown to be at least as beneficial as ibuprofen for osteoarthritis sufferers and with considerably fewer side effects, they do have some downsides. Glucosamine is often made from the shells of shellfish, so an allergy to seafood might make the supplement a dangerous additive. Some people report mild side effects like nausea, and there are some effects on insulin levels that may be harmful to people suffering diabetes. Young children should not be on these supplements and pregnant women (as well as women in their child-bearing years) should avoid it. Also, the Journal of the American Medical Association studied these supplements (and the studies) and found that while they were beneficial in helping with osteoarthritis, there was a great deal of exaggeration in the effects (by company sponsored studies) and that there are a lot of variations in the quality of the supplements. For these reasons, and perhaps a few more (like that many European doctors do not believe they are beneficial), glucosamine and chondroitin are prescription drugs in Europe. They are available over-the-counter from many different sources in the U.S., but we recommend you speak with a doctor before taking them and that you only take supplements that have been manufactured at a pharmaceutical grade. Your doctor can help you pick these, and there is a lot more information

about the various sources available on the web.

8.6.2 Creatine

Creatine is naturally stored in the muscles and supplies the body with a quick source of energy. Many studies have shown that if taken correctly, creatine can enhance athletic performance if the exercise lasts a very short time(think bouldering). Fish and meat are considered the natural sources for creatine, but technically speaking you don't actually consume the creatine that your body uses but instead create it when you consume various meat products. The creatine is stored in the muscles and then accessed when they are activated.

Our conclusion was that creatine was potentially useful to climbers only when they were training as it helped them build up muscle. When actually trying to climb, the adverse effects of the stuff seemed to negate its muscle building properties. Its known that one of the side effects of creatine is that it increases the body's natural water retention. For this reason, we saw a 2 – 3 kilogram weight gain in climbers who began taking creatine as a supplement. These climbers required a longer time to warm up to their peak level, and their regeneration time was shortened, but they saw no significant gains in over-all ability. It seems they might have actually gotten stronger, but the retention of water, and thus added weight, perhaps cancelled out the limited gains in strength (No... don't start thinking you will take creatine and not drink water. That will kill you!).
Creatine may have some benefits to climbers, but we could not prove them. If you decide you want to try it out, make sure you consult with a physician first. Creatine may have some adverse effects on the kidneys (they filter it out). Also, many climbers reported tighter muscles when they were on it, which could potentially lead to muscle strains and tears. Finally, creatine is, pure and simple, a form of doping. It is not yet regulated by the International Olympic Committee, but it probably will be very soon. If so, don't be on it in a competition.

8.6.3 Sodium Bicarbonate

Runners have been taking sodium bicarbonate for years. Studies have shown that in 400-3000 meter runs it was able to help to lower the acidity of the blood and thus improve times. Runners also felt they recovered more efficiently and were not as tired for as long after taking it. However, an abuse of sodium bicarbonate might lead to cardiac arrhythmia and muscle cramps. It will make you quite gassy as the stomach converts some of it to carbon dioxide. On top of that, we have not found any performance increases on climbers taking it.

8.6.4 Caffeine

As I type these words, my cup of coffee is spurring me on to the next paragraph. Caffeine, as taken in coffee, soft drinks, and tea, has been a part of our culture for centuries. Caffeine is also a performance enhancing substance. It works to help you in three different ways:

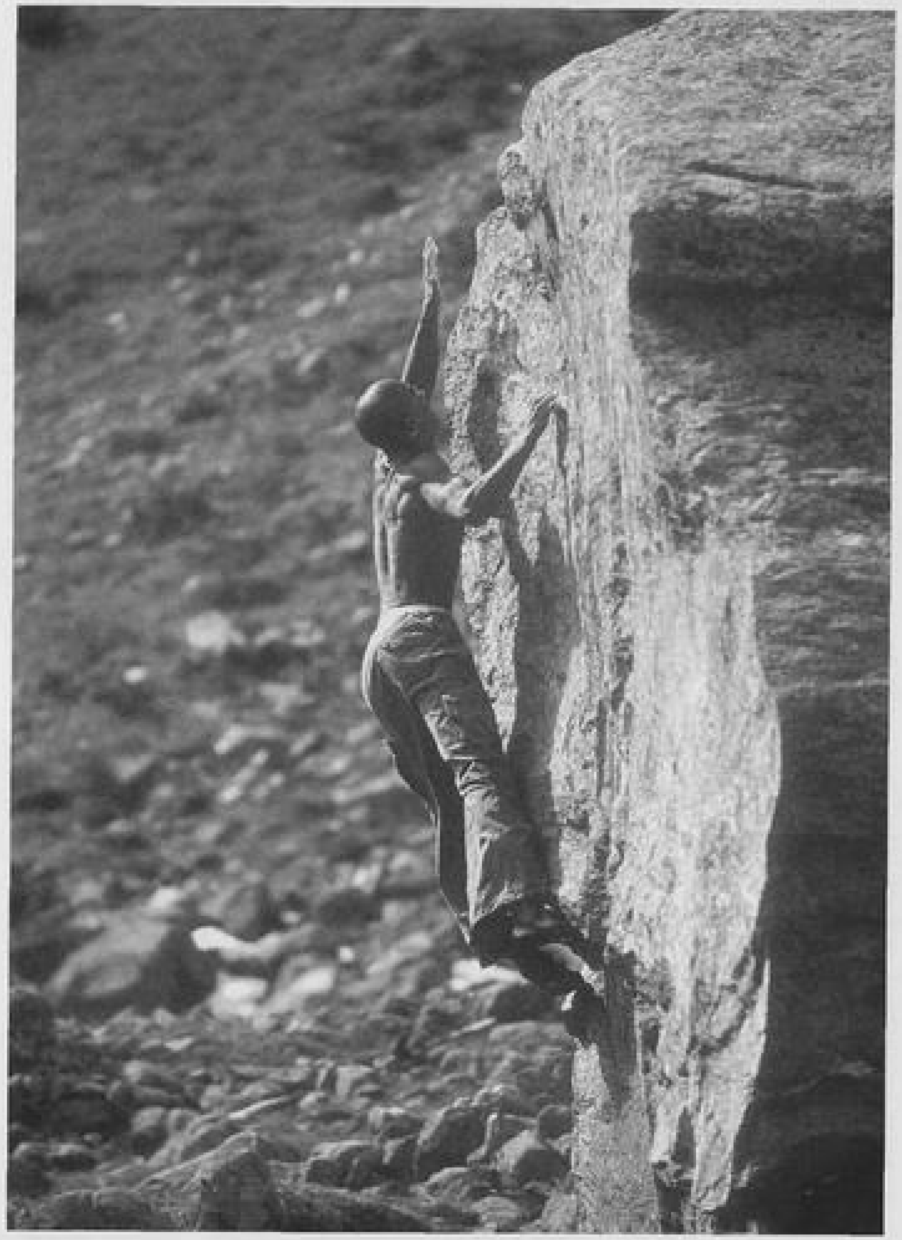
1. It improves alertness and shortens reaction time by stimulating the nervous system. Also, by stimulating the nervous system, it helps you to push harder as your perception of the point of exhaustion is harder to reach.

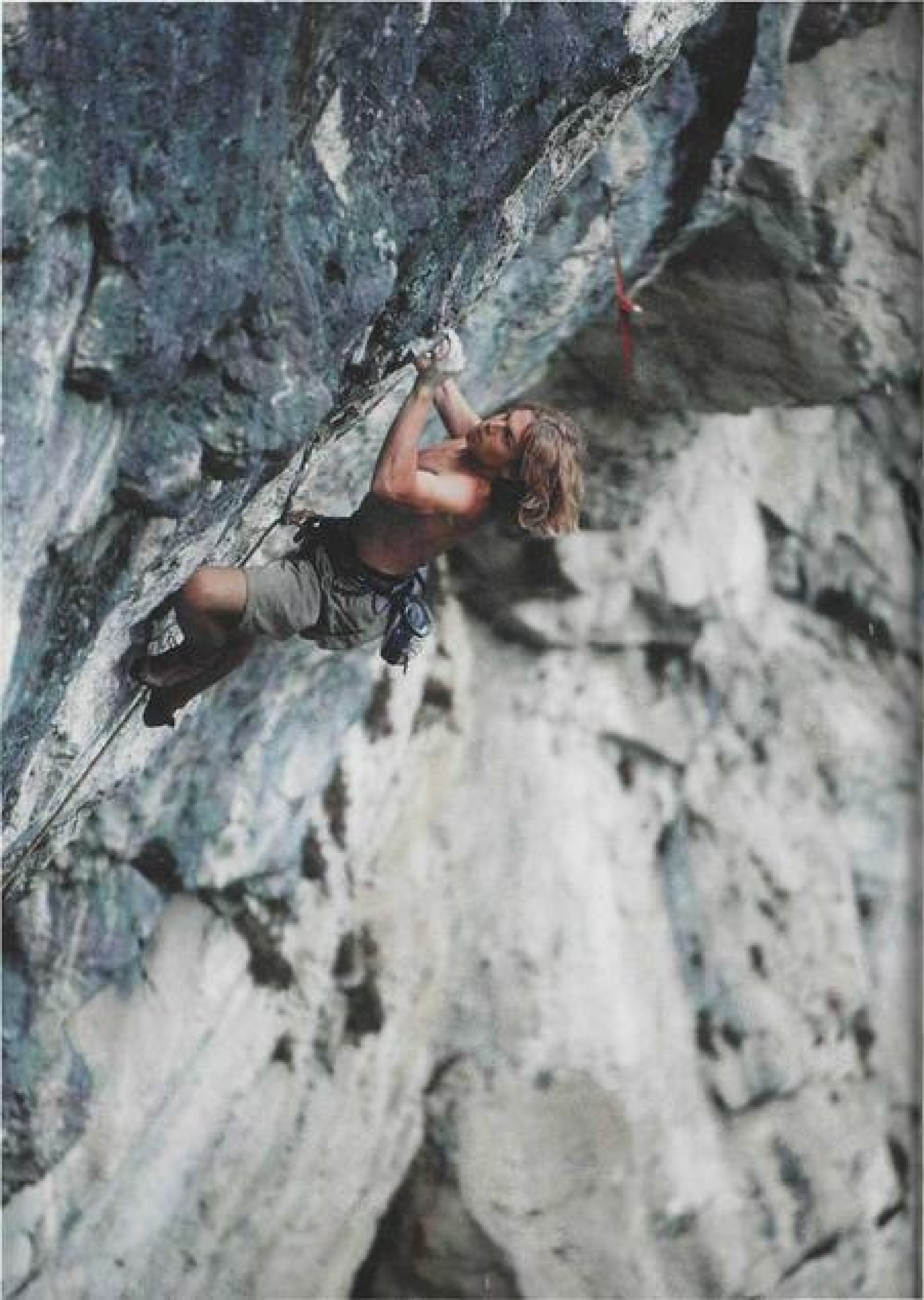
2. It raises the metabolism thus helping to burn fat and store carbohydrates to be used later in exercise.

3. It raises the calcium concentration in the muscles and decreases the potassium concentrations outside the muscles. This might lead to an extended point of fatigue.

Caffeine is so effective as a performance enhancing substance that it is banned in high quantities by the International Olympic Committee. The I.O.C. will allow a normal consumption of it, as in the drinking of a few cups of coffee, some soft drinks, or chocolate. However, if they find amounts in an athlete's urine exceeding roughly 5 mg. per kilo of body weight, they can expect to be reprimanded just as if they were on any other performance-enhancing drug.

Caffeine can have side effects that can inhibit performance. It can give you insomnia, nervousness, cardiac arrhythmia, and dehydration (not to mention stomach problems). It varies from individual to individual, but the very effects you seek from it can become so pronounced that they hurt you. In general it's best to use caffeine in the same level of moderation that our society already accepts. A little coffee or chocolate probably is not bad for you, but taking pill forms of the stuff can get you into trouble and seriously damage your health.





9. The Next Generation...

With the advent of sport climbing and the sheer number of gyms that offer a relatively safe environment, our sport has become very popular with young children and teenagers. Climbing–gym operators, non-climbing parents, and parents that have been active in the sport for years, often have the same questions about climbing and kids. "Is this sport dangerous?" "Do we treat this as a fun hobby or should we push him/her a bit to excel?" "Should we only let them climb at an indoor gym or should we let them go to outdoor venues as well?" These questions, and more, are very important to ask when kids are just beginning as climbers. Hopefully we can give you some information here that will help you to come up with some answers.

One thing to remember is that a climbing workout for a child or teenager is not just an abbreviated version of the adult workout. Their bodies are still growing, and like a Labrador retriever with a tennis ball, a kid will often keep trying to climb long after he or she should have rested those developing fingers and arms.

This chapter will focus on the medical ramifications of training for adolescents. As you read it, keep in mind that above all else, even to us success driven adults, climbing is supposed to be about fun. Becoming a so called "soccer parent" in a sport like climbing, where you push the kid to excel every day, will probably drive the child away from climbing or eventually get him or her hurt. Rock climbing, even inside a gym, is too committing and far too stressful on the body to be done in excess.

9.1 Physical Characteristics of Children and Teenagers

A muscular-skeletal system that has not fully matured is generally not developed enough to handle extreme physical

◁ *Guido Unterwurzacher on "Wassermusik" (8b+), Schleierwasserfälle/Austria* strain. On average, the human bone structure continues to grow until an adolescent is about 18 years old. It is known that our tissues are more sensitive to strain when they are growing than when they have reached full development, so extreme methods of training pose far more of threat to our health when we are 18 or younger.

It is important to keep in mind that differences in the ages of kids, perhaps of only a year or two, can make for much greater differences in ability. It's common knowledge that girls are often a year or more ahead of boys in development of their size and coordination. Even within the same sex, there can be differences between levels of physical maturity. One boy of 15 might have reached his maximum size, while another might still be in puberty. The less mature 15 year old might still have growth plates that are open, muscles like a child, and a much lower level of coordination, while the more mature 15 year old might have similar physical characteristics to what he will have when he is 19.

This of course means that what we say for kids is a generalization that you, the trainer, coach, or parent, need to understand and adapt to. Also, you can see how in a large group of kids natural competition might lead one kid to "over-do-it" when trying to keep up with his/her friend who is more mature.

Daniel Steurer on a nameless 7b+, Gorges du Tarn/France

9.2 The Effects of Climbing on Young Hands and Fingers

Again, there is a big difference between training an adolescent or a child, and training an adult athlete. However, there is not much difference in the climbing grades between today's kids and the adults. The top-level climbers are getting younger, and it is not uncommon for 16 year olds to be in the finals of World Cup competitions where the course grade is 5.14. Many pre-high school kids have climbed at this grade, and a few children under the age of 10 have even climbed 5.13.

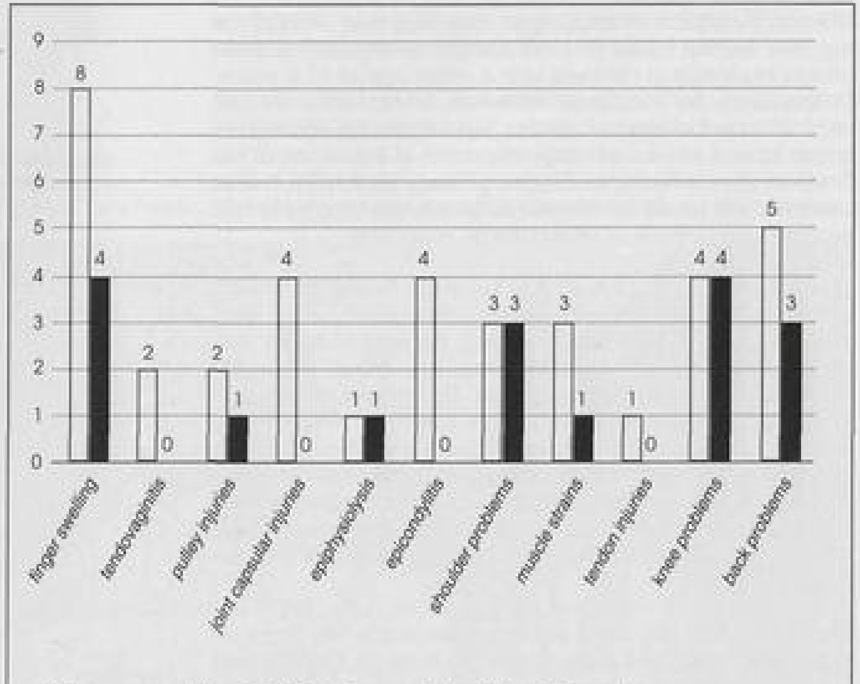
This high level of performance is hard on us as adults, but it may even be worse on the developing bones and joints of kids. While the radiographic (X-Ray) data on changes in older climbers has been charted, there is very little data available on the effects of climbing on kids. However, in 1997 we reported the first cases of non-traumatic epiphyseal fractures (stress fractures) in climbers with a mean age of 13.6 years. Unfortunately the incidence increased, and by 2002 we had seen 22 cases of stress fractures. Also in this time period we began to see a reduced range of motion in the hands of the German Junior National Climbing Team (G.J.N.T). It was clear that we as adults needed to give some thought to the possible early onsets of osteoarthritis in our kids.

The German Alpine Club (D.A.V.) and the Technical University of Munich (T.U. Muenchen) are jointly taking on the evaluation of risks to kids while climbing. Aspects of social, cultural, economic, training, and the safe use and development of equipment, are being researched. The project has already examined 19 members of the G.J.N.T. with an average age of 16.2 years where 15 were male and 4 were female. At the same time 18 young climbers (average age of 14.7 years) who approached the sport more as a recreation in their spare "play" time were studied. All of these climbers were examined clinically as well as with X-Rays of the right hand at various angles.

For the G.J.N.T. the mean climbing level was 5.12d (If the females were excluded the average grade of the G.J.N.T was 5.13b), while for the recreational climbers it was in the mid 5.10 grade. On average, the G.J.N.T. had been climbing for 5 years while the recreational climbers had been climbing for 2 years. The G.J.N.T. trained or climbed 3.7 times per week for an average total of 11.2 hours while the recreational climbers tended to climb more like 1.3 times per week with an average total of just over 2.7 hours. All of these kids did a warm-up prior to climbing, and stretching exercises for the forearms were done by 84% of the G.J.N.T. and 89% of the recreational climbers.

We found that six (32%) of the G.J.N.T. climbers suffered a decrease in the range of motion in their hands (roughly 5 – 10 degrees in their finger joints) while none of the recreational climbers had this problem. Eight (42%) of the G.J.N.T. complained about occasional swelling in their fingers, while only four (22%) of the recreational climbers claimed the same symptoms.

This diagram shows the injuries suffered to both groups:

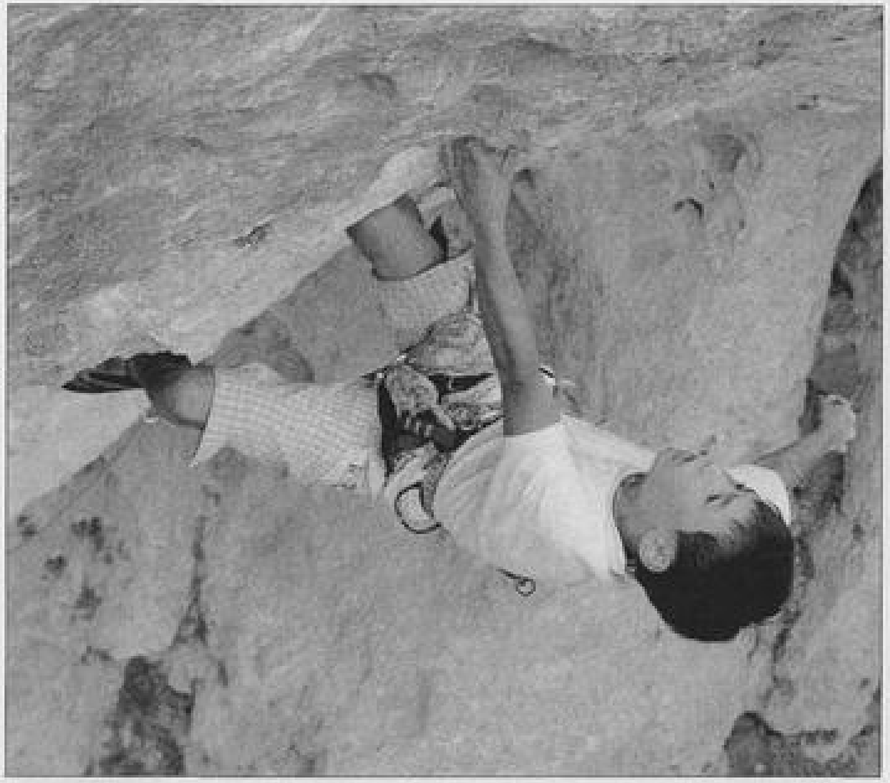


White represents the G.J.N.T. (German Junior National Team)
Black represents the young recreational climbers.

This table shows the training analysis of both groups:

Parameter	GJNT	STC
Total number	19 (m=15, f=4)	18 (m=16, f=2)
Number of years climbed	5.0 ± 2.6	2.0 ± 2.0
Number of years trained	2.8 ± 1.8	1.3 ± 0.6
Do you do competitions	19 (100%)	6(33%)
Do you have a trainer (yes)	14 (74%)	12 (67%)
Do you have a training plan (yes)	13 (68%)	0
How much climbing/training per week	3.7 ± 0.9	1.3 ± 0.7
Training hours per week	11.2 ± 5.1	2.7 ± 2.6
Do you do other sports (yes)	17 (89%)	17 (94%)
Climbing level	5.12d	5.10d
Climbing level 1 year ago	5.11c	5.10a
Climbing level 2 years ago	5.10d	5.0
Ho many minutes rest between climbs	18.8 ± 11.1	9.41 ± 2.4
Training methods:		
Do you train crimping	10 (53%)	3 (17%)
Do you use the Campus Board	2 (11%)	1 (6%)
Do you use additional weights	2 (11%)	1 (6%)
Do you train specifically for max. power	17 (74%)	1 (6%)
Which muscle groups do you train especially:		
Upper arm	14	7
Finger extensors	5	0
Finger flexors	4	0
How many minutes do you warm up before climbing	16.4	13.1
Do you stretch	16 (84%)	16 (89%)
Do you have a special diet	0	0
Did someone tell you about the risks in climbing, what to do, and what to avoid	19 (100%)	17 (94%)

Looking over these results you can quickly see the positive aspects of their training. Young kids are already learning to stretch and warm up. That can't be said for most adults! Also, the fact that they are avoiding climbing with extra weight and are not using the campus board is good.



David Lama on "Le Ventre" (7c), Gorges du Tarn/ France

It was clear that having a trainer was supportive for the G.J.N.T. kids. All of them had a fairly good level of understanding about the mechanics of their bodies and how injuries occur. Many of these kids understood how crimping increases the amount of force on their fingers, how stretching helped with the warm up, and how to maintain a healthy diet. Some of this information came from their parents, but most came from the trainer and from contact with other climbers (often through the trainer).

Specifically concerning diet, it was good to see that none of these young climbers felt they were too heavy for the sport. The average body mass index (B.M.I which is defined as Weight in kilograms ÷ [Height in meters]2) for the G.J.N.T. was 20.1, while the recreational kids had a B.M.I. of 18.9. The fact that the Junior Team kids were the heavier of the

two groups shows that their trainer and their parents were not promoting any sort of dieting. It may sound a bit odd that we give this such support, but the fact is that we have heard of parents and trainers who are promoting weight loss in their kids and, in some cases, even holding food back from them. As far as we are concerned, holding food back from a child because you want to see them succeed in climbing is no different than putting a junior high football player on steroids. It's wrong.

Keep in mind that almost all of the above-listed injuries happened while training and not while climbing. This is partially because we defined training as indoor climbing, but also because these kids spend around 80% of their climbing time in gyms. As expected, most of the injuries happened when crimping on small holds. Each child wisely went to a doctor as soon as the injury took place... something most adults don't do.

There really is no place for the campus board, the double dynamo, or the use of additional weights, in anyone under the age of roughly 18 – 20 years old. As stated in the Injuries chapter, these methods of training for maximum power create incredible loads of stress for your hands, elbows, and shoulders. It could be argued that a specific training program where maximum power is being sought is not something for younger climbers. A point to support this concept is that all of the stress fractures we saw were in climbers who had been using the campus board in their training. The bones of these kids are still developing and are thus partially made up of cartilage. Being a more flexible osseous material, they are more susceptible to injury under intense levels of pressure.

It is important that the kids have a trainer or supervisor who can explain the dangers associated with intense training. Adults can give guidance so that the permanent overuse injuries and decreases in range of mobility (something that should definitely be avoided in developing bodies) are avoided. Setting up good habits at an early age will help them to have a longer and far less painful life of climbing. If only someone had told us!!!

Some people have come to the conclusion that kids should not use the crimping position at all. We do not see that as an intelligent approach to training for the sport. First of all, crimping is the body's natural reaction when positioning the hand on a hold, so everyone will automatically try to do it and have a hard time learning not to. Second, bone, cartilage, and connective tissues, need some stress to develop a higher level of strength. If we were to neglect crimping altogether while training, the physiological adaptation to that possible stress will not materialize. When the kids do crimp, which they will do when they climb on the naturally odd shaped holds outdoors, they will be more likely to suffer an injury. What makes the most sense from a sports-medicine standpoint is to select the holds used in training that are anatomically designed to be safer. By using these better-designed holds on routes indoors, the adaptations will be achieved through the safest and most controlled means possible.

NOTE

Training Methods and Devices with Devastating Effects on Bone and Cartilage

Campus Board
Additional Weight
Extreme Bouldering
Too Many Dynamic Moves
Constant Use of the Crimping Position

9.3 Results of X-Rays

We broke down the X rays of the above-mentioned kids into the categories of physiologic stress reactions and early-stage osteoarthritis. We defined stress reactions as any indicator that the bone and cartilage have been put under stress but have not yet developed indicators towards serious problems. In short, our feeling was that "stress reactions" were potentially bad, but in the long term they would likely be dealt with through physiological adaptation. Relax, parents; you could expect this in any sport. It makes sense that a child who plays soccer would develop sturdier knees than he/she might otherwise have. An example physiological adaptation in climbing would be the bones, joint capsules, and ligaments of the fingers getting thicker so as to handle the extra load.

We defined the early-stage osteoarthritis signs as injuries and overuse syndromes that were at least a step further along the damage scale. These were defined as injuries that

probably would lead to long-term health problems and where adaptation would not overwhelm the problem.
Forty-seven percent of the G.J.N.T and twenty-eight percent of the recreational climbers showed signs of stress reactions. These reactions varied from increased thickness of the bone to widening of joint bases. What was disturbing was that some of the signs of early stage osteoarthritis were present in one member of each group.

	GJNT	RECREATION
Number	19 (m=15, f=4)	18 (m=16, f=2)
Stress reactions	9 (47%)	5 (28%)
Cortical hypertrophy	5 (26%)	2 (11%)
Subchondral sclerosis, increased thickness of epiphysis	9 (47%)	1 (6%)
Calcification of insertion of flex. sup. or flex. prof. tendon	0	0
Broadend joint base PIP	8 (42%)	5 (28%)
Broadend joint base DIP	3 (16%)	0
Early Osteoarthritic reactions	1 (5%)	1 (6%)
Osteophytes PIP	0	0
Osteophytes DIP	0	0
Decreased jointspace	0	0
Subchondral cystes	0	0
Epiphyseal fractures (stress fractures)	1	1

Out of 604 injured climbers in Germany, we only found two cases of stress fractures. The discovery of these two cases, one in each group of kids, is quite disturbing. There seems to be a direct correlation with certain training methods as both of these kids were known to do a lot of crimping exercises.

So far, it appears young "hard-core" climbers do not suffer early osteoarthritis more often than young recreational climbers. However, the G.J.N.T. had over double the number of stress reactions that the recreational climbers suffered. These stress reactions, which may be dealt with by the body in an adaptive manner and may result in long-term problems, should not be forgotten. Also the climbers in the study had

only been in the sport for, at most, 3 to 5 years. Another 20 years of monitoring these kids will tell us a lot.
The one thing that should not be missed here is that of the three climbers who trained for maximum power on the campus board, two (66%) had stress fractures in their hands. Considering the potential for problems, it is safe to say that the dangerous training methods of crimping and using a campus board should not be done.

NOTE

"Johnny! Stay Away from that Campus Board"
We feel it is important to point out that this study was conducted in Germany where the training of kids is done with a minimal emphasis on the campus board.
We have seen many other kids climbing at a high level of ability, especially from Austria, who have incorporated the campus board into their training routine.
These kids have not been made a part of a formal study, but our examinations of them have shown a much higher incidence of stress fractures and early signs of osteoarthritis.

9.4 Injuries to the Feet

Our study has also been monitoring the potential damage climbing and training are doing to the feet of both the recreational group and the G.J.N.T. Overall, we can say that the kids are probably not as focused on tight fitting shoes as adult climbers. This is partially due to the fact that they are spending most of their time on indoor walls where tight fitting shoes are not as important. Nevertheless, we did find a higher incidence of hallux valgus (see a description in the Overuse Syndromes chapter) in the young climbers who had been active in the sport for a relatively longer time. There were pressure marks on the toes of 74% of the G.J.N.T. and 28% of the recreational climbers. While the marks themselves are not dangerous, they do show an added level of stress being placed on the feet.

9.5 Injuries to the Growth Plates of the Fingers

Near the joints in a child's fingers there are thin areas of cartilage commonly known as growth plates (epiphysis). These plates allow additional osseous material to fill in from either

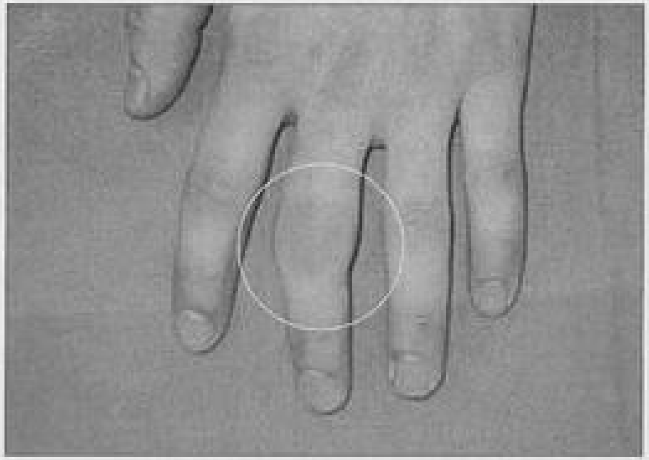
end of the bone and thus let the skeleton to expand in length. Unfortunately, the plates are quite susceptible to injury.
Since 1994 we have seen at least two dozen young climbers in our clinic who were complaining of a slow onset of what became chronic pain in their fingers (this "group" is not part of the previously mentioned study). These young climbers had no sudden, acute trauma to the fingers, but did slowly develop enough pain and swelling that they could no longer crimp. Every one of these climbers, that is 100%, had X-rays that indicated some damage to the growth plates. In some cases, the growth plates were partially detaching from the bone.

Injuries to these structures during growth will very likely lead to permanent damage if they are not treated. Even with treatment, they may have permanent damage. Interestingly, young boys seem more susceptible to these injuries than young girls. This is perhaps because during puberty boys have an elevated level of testosterone, a hormone that has been known to weaken the mechanical firmness of the growth plates.

This does not mean that adolescent boys should not climb and it definitely does not mean that youngsters in general should not climb. However, carefully monitoring by adults of how kids feel after climbing and during long periods of training is a must. Also, those training methods that are particularly hard on the body, like crimping and working on the campus board, should not be done.

Left:
X-Rays of damage to the growth plates and the joint

Right:
The same climber two years after the injury. It is likely this kid will have chronic problems in this finger.



Results of epiphyseal fracture: broadened joint and bend finger (20°)

9.6 Injuries to the Growth Plates of the Ankle

A common injury when bouldering is the straining of the ligaments in the ankle. For kids, it is also possible to fracture the growth plates in the ankle as well. Remember to keep the mats correctly placed to help prevent this. Also, if the pain is consistent and continues for a week, make sure you get a second X-ray to confirm there is no fracture. Long-term problems could result if a fractured ankle growth plate is not properly diagnosed and treated.

SYMPTOMS

Symptoms of Growth Plate Damage

- Swelling in or near the joints
- Constant Pain
- A lack of mobility in the fingers

THERAPY

Therapy for Growth Plate Damage

- Consult a doctor immediately
- X-Rays to determine if there is damage
- Immobilization for up to three weeks
- If there is a fracture, perhaps surgical repair

9.7 Recommendations for Supporting that Future "Hard-Core"!

1. Make sure an adult, who can oversee the training practices, is working with the kids.
2. Get an annual medical checkup from an orthopedic doctor who understands the stress of modern rock climbing.
3. Eat a balanced diet and make sure your child gets all the necessary nutrients for growth and development (no avoiding fat!).
4. Do other sports. It's important that kids keep a mental, as well as physical, balance with their activities. Besides, you're a geek later in life if you can't play with a ball on your rest days!
5. Parents need to watch each other. Overly pushy parents could create an arthritic, burned out, anorexic, 19 year old who hates climbing.
6. Make sure the kids are getting enough rest. Kids are so energetic that they often forget to take time off. They need rest as much as we do.
7. Competitions are fun, but keep a close watch on all the aspects of training that lead to that competition.

9.8 Inside or Out

These days most kids are making their first climbing moves on artificial walls in gyms. They need to learn from the gym instructor how to use the equipment safely and how to properly belay. A young mind is easily distracted, so constant supervision must be maintained when they are belaying.

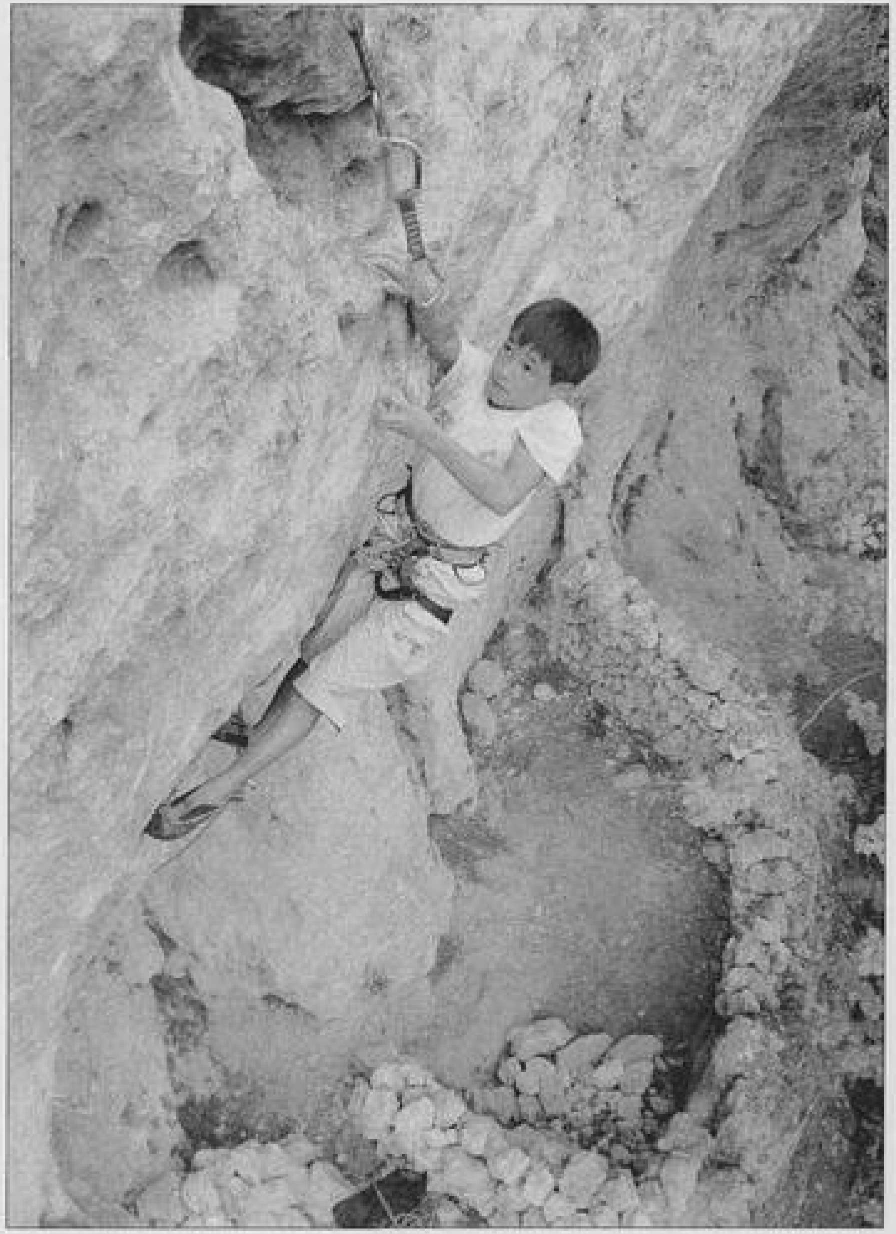
If there is any point at which you need to really be worried about your child's health as a climber, it is when (and if) they decide to take their indoor sport to its original spot in the outdoors. A climbing gym is a controlled environment where the equipment is checked continually and there are people making sure (hopefully) that safe practices are being followed. Outdoors, a climber is purely under his or her own control. It's barely a place for adults, and no place for kids on their own.

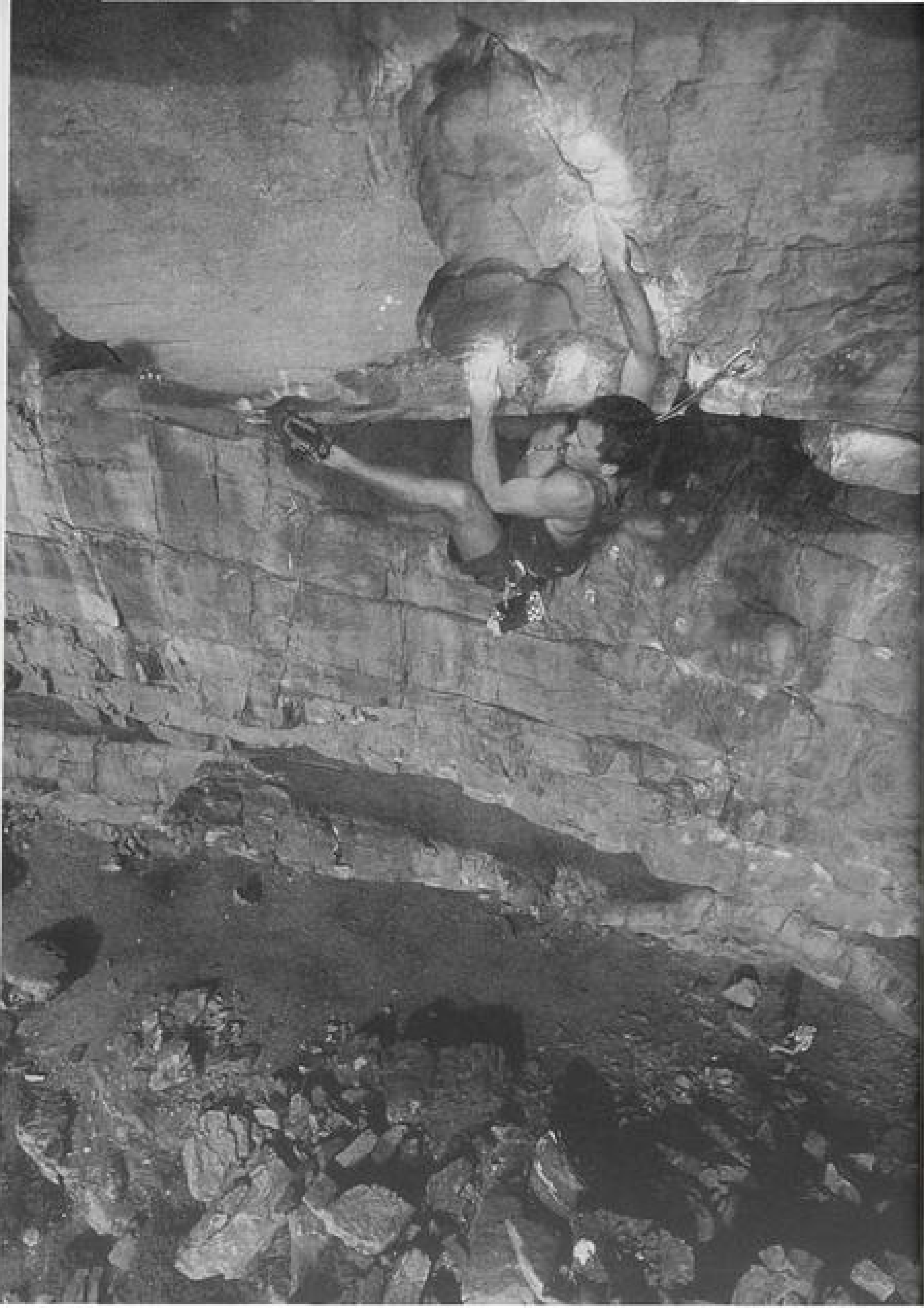
In the last few years the number of accidents in North America's mountains have gone up considerably. This is in large part to a misunderstanding of the climbing environment and an over simplification of the sport when a "gym" climber moves outside. Many of these accidents occur when a gym climber sees a "5.7" in the guidebook and says, "I can do that because I've climbed a 5.10 in the gym before." While the physical difficulty may be expressed in the number grade, the knowledge needed to climb outdoors is far greater than that needed for inside.

If there is any advice we can give you so that your child safely makes the transition from indoors to outdoors, it is that you hire a qualified guide to teach them. Guides can be found on the Internet, in the yellow pages, or perhaps even through the gym. Make sure your kids spend a number of days out with their guide so that they can learn the ropes correctly. If so, they will most likely have a long and safe climbing career.

Florian Lochner bouldering at his favourite indoor wall

Opposite: David Lama on "Le Ventre" (7c), Gorges du Tarn/France





◁ *Jeremy Wilse-Samson on "Gift of Wings" (28), Kapstadt/South Africa*

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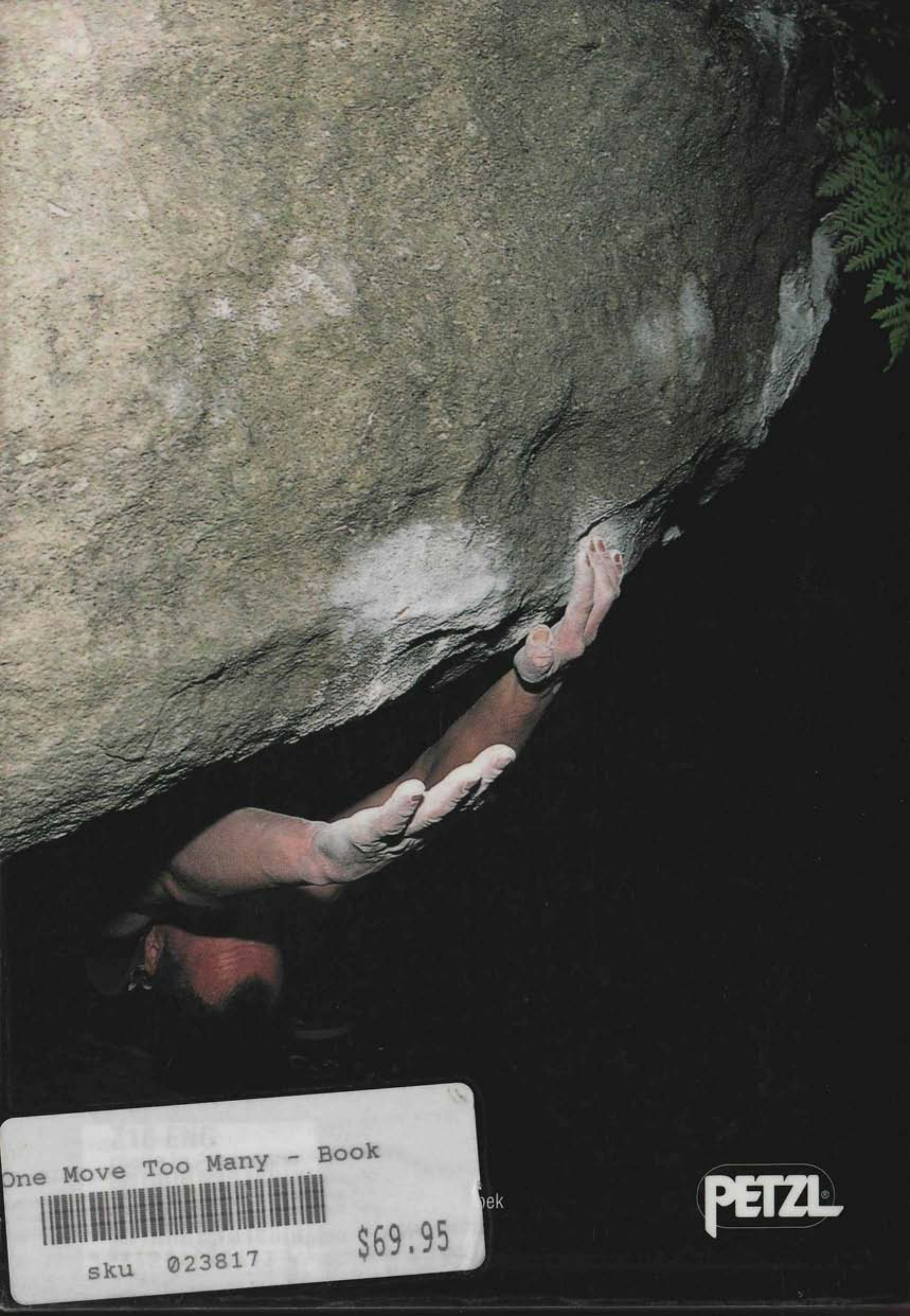
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