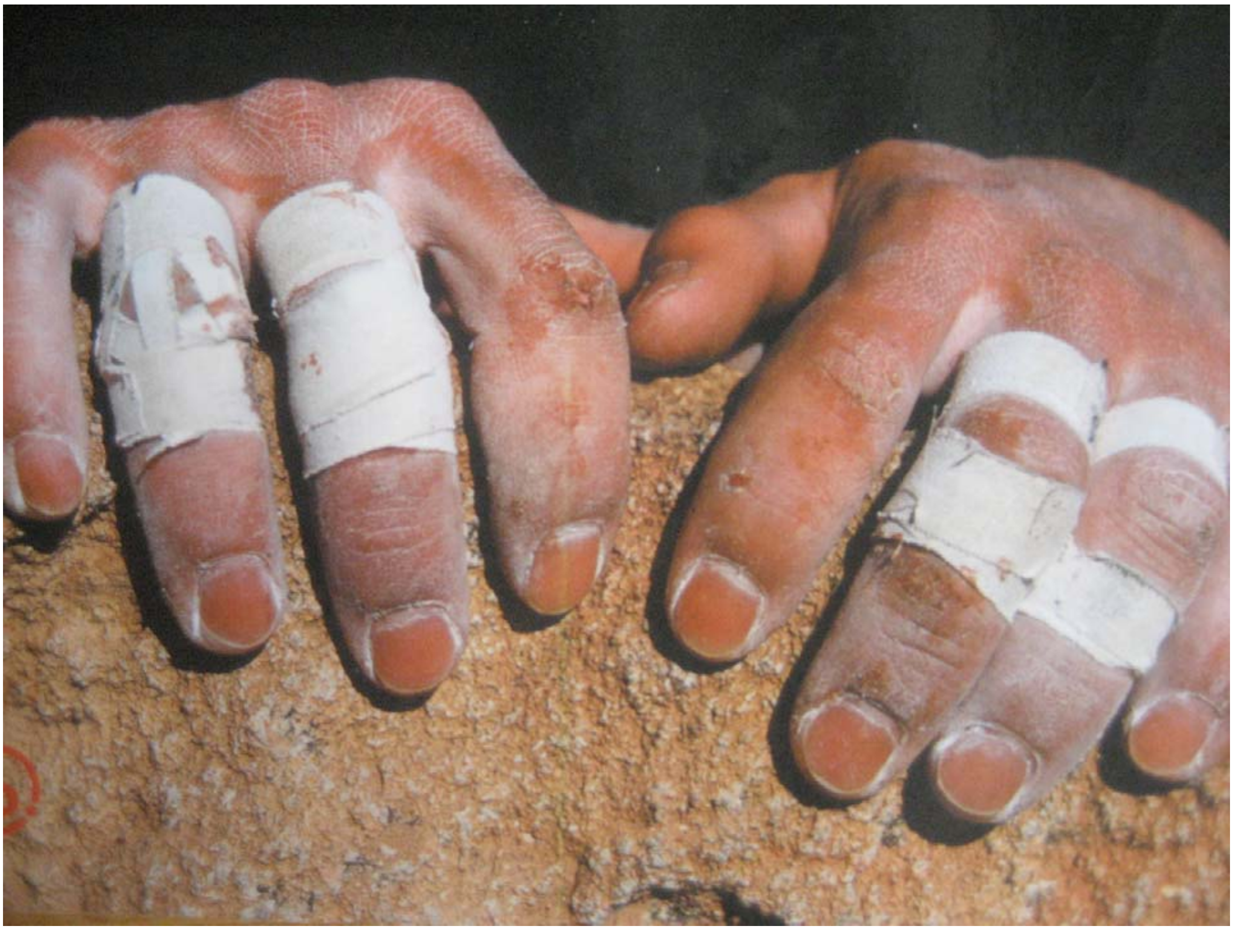
Masters Thesis an der Donau-Universität Krems

Performance-enhancing Osteopathy in Sport Climbers with Finger Injuries

Submitted by Michael Otepka, Innsbruck 2006

„Es gibt keinen wirklichen Unterschied zwischen Struktur und Funktion, sie sind die zwei Seiten der gleichen Medaille. Wenn uns die Struktur nichts über die Funktion sagt, haben wir sie nicht richtig betrachtet“
Dr. A.T. Still

„It’s totally right that climbing on one-finger holds is an extreme impact on one finger, but all the other fingers will be totally spared out”
W. Güllich (Sport-Climbing Legend)



To all my Friends

1 Introduction

1.1 Definition of Sportclimbing

In Sportclimbing, the structure and difficulties of a natural or artificial wall are accepted and the aim is to master gravity by climbing that wall without any aid. Certain rules must be followed in order to allow for objective comparison with other climbers:

- A route is only climbed correctly if done “redpoint”: the belay chain (rope, bolts, and karabiners) is used only for security and is never loaded during the climb.
- The number of trials or the maximum height reached allow for comparison (Hepp 1992; Glowacz 1989).

If these rules are accepted, sport climbing is independent of difficulty. The grade of a route is based on the size of the holds for fingers and feet, the steepness of the wall and the complexity of the single moves (Güllich/Kubin 1986, 19).

Figure 1: Sportclimbing of a very difficult route

1.2 History of Sportclimbing

In the beginning of the 1970`s a new word burst into the alpine vocabulary: Sportclimbing. Conceived in the Californian climbing areas, this ideology was born in the 60`s. In Europe, a new generation with a new attitude was looking for new challenges: climbing with competitive aspects and exact rules. This new mentality led to an unbelievable increase in the performances and difficulties. While earlier rock climbing was done in the mountains, Sportclimbing is performed in climbing areas close to the valleys and cities (Hochholzer/Schöffl 2001, 4).
All over the world new climbing areas are developing. In the last 10 years, indoor climbing walls have also boomed, making it possible to train year-round. New materials and security techniques are contributing factors to why this sport has become so popular. The state of art has been pushed higher and higher, and now some professionals are able to climb the 9th grade in the French rating system which was unimaginable only 15 years ago (Burmester/Stöhr 2004, 59).

Since 1990, there is a world cup and world championships with high financial incentives from sponsors and the industry. Professionalizing and commercializing have led not only to higher performance levels and increased popularity but also to new problems in sport medicine: Previously unknown injuries and damage due to over-use have emerged (Klauser et al. 1999).

1.3 Training and Over-use Injuries

The most important factor for success in long-term training, and for achieving the associated increase in performance, is the continuity of training (Güllich/Kubin 1986, 132). An interruption of this continuity because of injuries, irregular training, and too long breaks between each training interval can lead to a decrease of the performance level (Weineck 1990, 22).
Apart from the feet, the most important tool for any climber are the fingers. On difficult, and especially on overhanging routes, the entire body weight is sometimes placed on one or two fingers, due to the small grips and/or limited placement for the feet. The fingers have to transfer the muscle power to the rock in a very complex way.

The strength of the fingers is the limiting factor in Sportclimbing. Therefore, one of the main goals of training has to be in strengthening them (Güllich/Kubin 1986, 168). Ambitious climbers employ specific exercises, like training on a campus board, to improve the finger power.

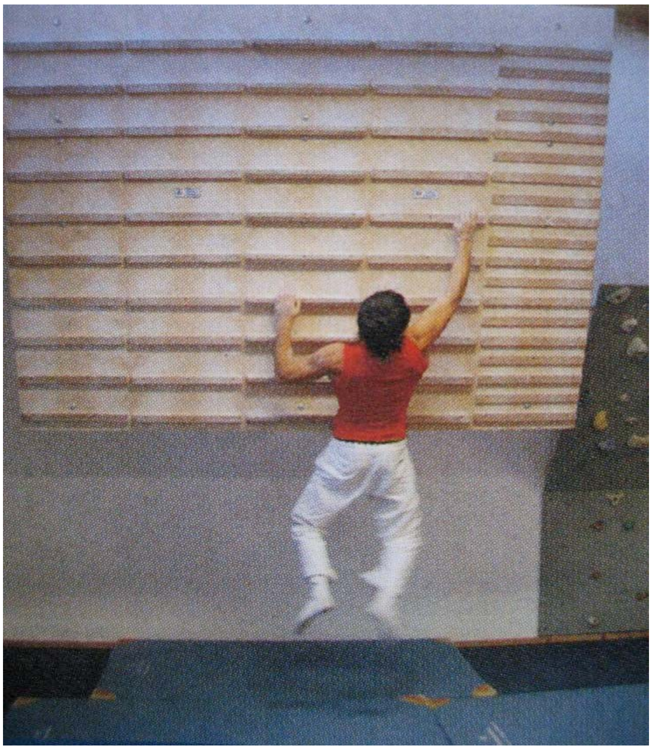


Figure 2: Training on a campus board

Watts et al. reports that elite climbers can perform longer bent arm manoeuvres, hand grip tests and do more pull ups than their non-climbing counterparts (Watts et al.1996, 185). Long-term, one sided loads can lead to micro traumas and, if the athlete continues to train, an over-use injury can be the result. Most of the time soft tissues, such as tendons, tendon sheaths, annular pulley ligaments, or the finger joints are affected because they adapt more slowly to specific impacts than muscles.

In case of an annular pulley injury, the recovery time is from 3 to 6 months. In case of several injuries or ruptures, an operation may be indicated (Hochholzer/Schöffl 2001, 42). Also Bollen found that the injuries most frequently seen in sport-climbers are over-use injuries. Specific training techniques result in high forces within the proximal interphalangeal joint and the digital pulley system, causing the finger injury known as climber's finger. Climber's finger has been observed in 50% to 69% of extreme rock climbers (Bollen/Gunson 1990, 16-18).

If the fingers are painful and swollen, some of these athletes reduce training quantity and intensity, tape their fingers, or see a doctor who gives them anti-inflammatory drugs or cortisone injections.
Very often these athletes are also afraid that they will loose their training level if they take a break for too long and therefore continue their normal climbing routine although their fingers hurt when holding a grip. According to Hochholzer, this can lead from overuse injuries to overuse damage with irreversible changes (Hochholzer/Schöffl 2001, 59).

I contacted Dr. Klauser from the Universitätklinik Innsbruck, Department for Radiology, who has made a name for herself in the evaluation of climber's fingers using ultrasonography, for expert advice on the forces climbers have to deal with. With the new ultrasound devices, it is now possible to make an exact diagnosis of the injuries causing the different symptoms in the fingers. These include annular pulley injuries, joint capsular lesions, tendovaginitis, cysts, fibrous tissue or fluid collection. I also put up notices in climbing gyms to find climbers with painful fingers.

1.4 Sportclimbing and Osteopathy

I have been an enthusiastic climber for 20 years. My hobby has brought me to some of the best climbing areas all over the world and many of my friends share my passion. As an osteopath and Sportclimbing instructor, I am often confronted with the typical lesions that cause a reduction in training or, in some cases, even force the climber to take a break from climbing.

However, hardly any climber ever sees a therapist or an osteopath. Child describes this poignantly in his humoristic book about the philosophy of climbers: "all you guys ever do is talk about your injuries" (Child 1998, 41).

2 Hypothesis

My hypothesis is that an osteopath can help patients with the typical climber's finger syndrome (see 1.3) and get them back to their normal training routine more quickly than climbers with any other kind of therapy or those with no therapy.
Orthopathic medicine, a combination of orthopaedic techniques and osteopathy, using the fascia torsion model and the treatment of the thoracic spine, was the basis of my work.
As far as I know, no similar study has ever been done, and maybe this work can help to make Osteopathy better known to climbers and physicians dealing with sport-climbing injuries.

3 Functional Anatomy

3.1 The flexor tendons and accompany structures in the Finger

Two muscles are responsible for the flexion of the 2nd-5th fingers. The bodies of these muscles are located on the ventral side of the forearm; therefore, these are so called extrinsic hand muscles. The superficial digital flexor muscle originates on the medial epicondyle of the humerus, the coronoid process of the ulna, and on the radius. The tendon, which divides into four separate tendons proximal of the carpal tunnel, shares a common sheath with the tendons of the profound digital flexor muscle. The tendons insert on bony ridges on the radial and ulnar sides of the middle phalanges 2-5.

The second main flexor, the deep digital flexor muscle, originates on the interosseal membrane and the proximal ulna. The deep tendons perforate the tendons of the superficial digital flexor and then insert on the base of the distal phalanges.

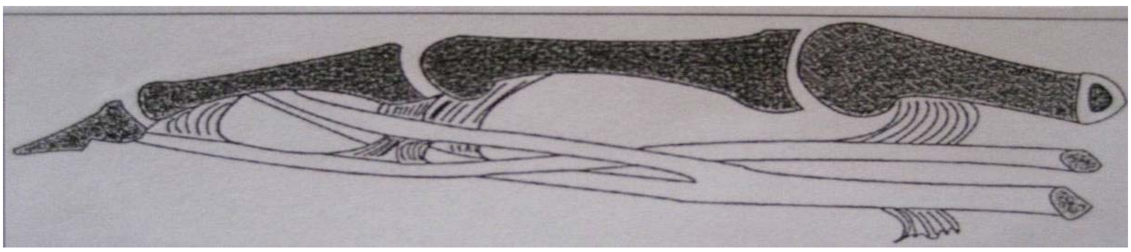


Figure 3: Course and start of the superficial and deep digital flexor tendons at the middle and end phalanx of the finger (Kapandji 1992, 193)

Additionally, the lumbricoid muscles, which originate on the tendons of the deep digital flexor, are responsible for a flexion in the metacarpo-phalangeal (MCP) joint while causing an extension in the proximal and distal finger joints. The deep digital flexor bends in the radiocarpal joint and in all the finger joints. It is the only flexor for the distal interphalangeal (DIP) joint.

If the distal deep digital flexor tendon is injured, it becomes impossible to bend actively in the DIP joint and the finger remains in the stretched position. The deep flexor develops its maximal strength when the MCP joint is extended. The superficial digital flexor is a weak flexor in the proximal joints, however its maximal strength is revealed when the MCP is stretched. This is based on the antagonistic-synergistic function of the flexor and extensors.

For rock climbers this means that the maximal strength for the fixation of holds can be developed when the wrist is over-extended and the MCP joints are maximally stretched. This is favoured by the stretching of the flexors which optimises power development in the muscles (Hochholzer/Schöffl 2001, 15).

The isolated injury or rupture of the profound digital flexor muscle causes a loss of strength when the DIP is stretched and the PIP is fixed.

The superficial digital flexor has one muscle body per tendon, while the deep digital flexor has only one muscle body from which all four tendons originate.

The flexor tendons are supplied with blood from four side branches of the digital arteries by the so-called vincula. These vincula tendinorum divide the deep tendons into levels. Areas that are under-supplied with blood are where injuries or ruptures are most likely to occur.

One of the areas under-supplied with blood is where the tendons are partially nurtured by the synovial fluid. This emphasizes the absolute importance of an intact tendon sheath when the flexor tendons are carrying the maximum load while climbing. The carpal tunnel, which is completed by the palmar retinaculum, contains the three tendon sheaths of the flexors: the palmar syniovial sheath of the radial carpal flexor, the long pollicis flexor and the common sheath for the superficial and deep digital flexors. The median nerve also passes through the carpal tunnel and can be compressed under certain circumstances.

The palmar digital flexor sheath begins approximately at the height of the MCP joint. It is supported by fibrous structures, the fibrous digital sheath. Without their support, the tendons would take a bowstringing path and become insufficient due to a relative lengthening of the skeletal structure.

The fibrous tendon sheath consists of two structures: the annular ligaments (ligg. anularia A1-5) and the weaker cruciform ligaments (ligg. cruciformes C1-C3). The five annular parts are found between the base and middle phalanx, while the three cruciform parts are found in by the MCP and PIP joints.

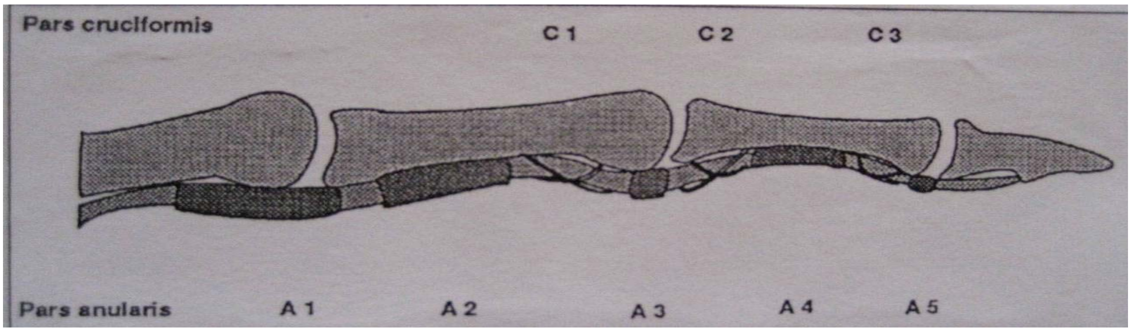


Figure 4: Representation of the digital flexor tendon sheath with its annular (A1-5) and cruciform (C1-3) parts (Kapandji 1992, 187)

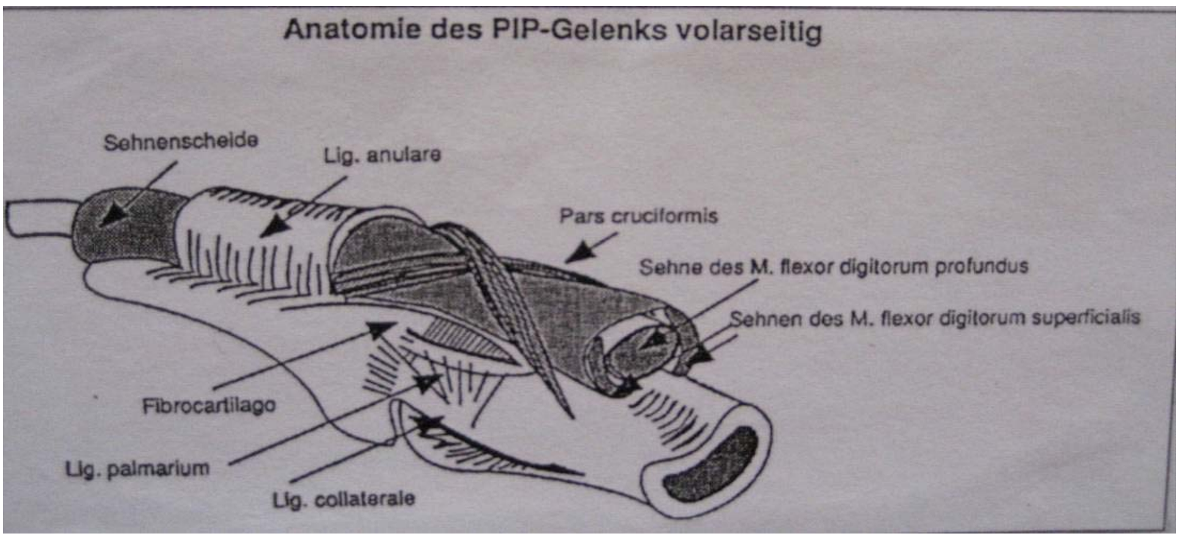


Figure 5: Anatomy of a flexor tendon and its sheath at a PIP joint of a finger (Kapandji 1992, 187)

The A2 and A4 play the most important functional role as abutments, while the cruciform ligaments could be negated. These cruciform ligaments, as they play no important functional role, can be split to treat flicking fingers. The synovial sheath consists of an inner layer that lies directly on the tendon and an outer layer that lines the inner surface of the fibrous sheath. Between these two layers is a thin film of synovial fluid. When the tendon moves within the sheath, the layers glide against each other. If the two layers grow together and become adhered as a result of tendonitis, it becomes impossible for the tendon to glide and move smoothly (Kapandji, 1992).

3.2 The fascia of the forearm (fascia antebrachi) and hand fascia

The fascia of the upper extremity represents the continuation of the superficial cervical fascia and is connected with the fascia of the ventral and dorsal sides of the trunk. It ends at the fingers; however, it is partially fixed at the elbow and wrist. A number of veins, lymph vessels and nerves run along the surface of this fascia or penetrate it. It has longitudinal and oblique fibres which are interwoven to make the tissue stronger. According to Paoletti (2001, 41) several layers can be identified:

- Sagittally, the intramuscular septa, which fix the fascia to the periostium and continue into the bone trabeculae and
- Longitudinally, the muscles and the structures of deeper fascia layers.

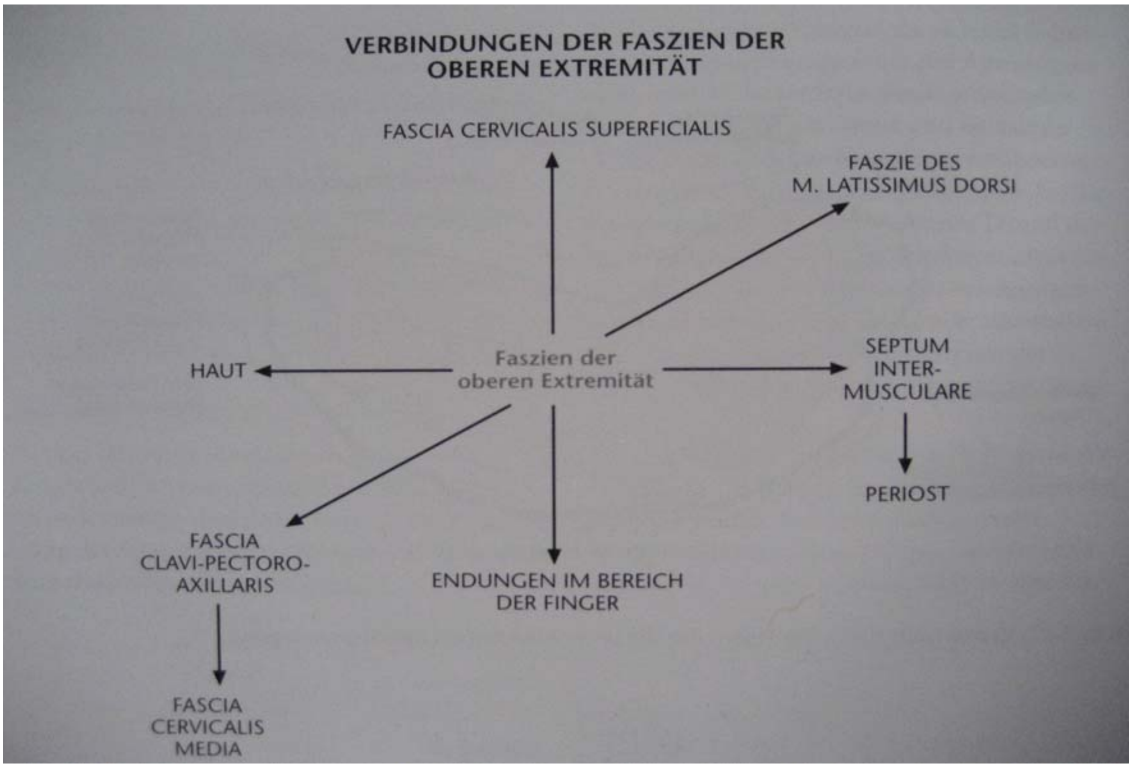


Figure 6: Connection of the fascia of the upper extremity (Paoletti 2001, 40)

3.2.1 The Antebrachial Fascia

This fascia is a continuation of the upper arm fascia. It ends at the wrist, where it is reinforced by the retinaculum flexorum and extensorum. The tendon of the brachial muscle is attached to the antebrachial fascia. On the posterior the triceps and the brachial muscles are also attached to the fascia and make it stronger.

The antebrachial fascia is stronger on the back side of the arm than on the front side. At the back, there is a strong connection with the posterior margin and the dorsal surface of the radius. Together with the bones, the fascia is basis of the palmar and dorsal region of the forearm. There are several connective tissue layers emerging of the deep antebrachial fascia which envelope all of the muscles, making them mobile relative to each other. On the palmar and dorsal sides, there is a superficial and a deep fascial layer (Paoletti 2001, 37).

3.2.2 The Hand fascia

This fascia is the continuation of the forearm fascia distal to the retinaculum flexorum and extensorum. There is a dorsal and a palmar aponeurosis (Fascia dorsalis manus and Aponeurosis palmaris), both of which contain a superficial and a deep layer.

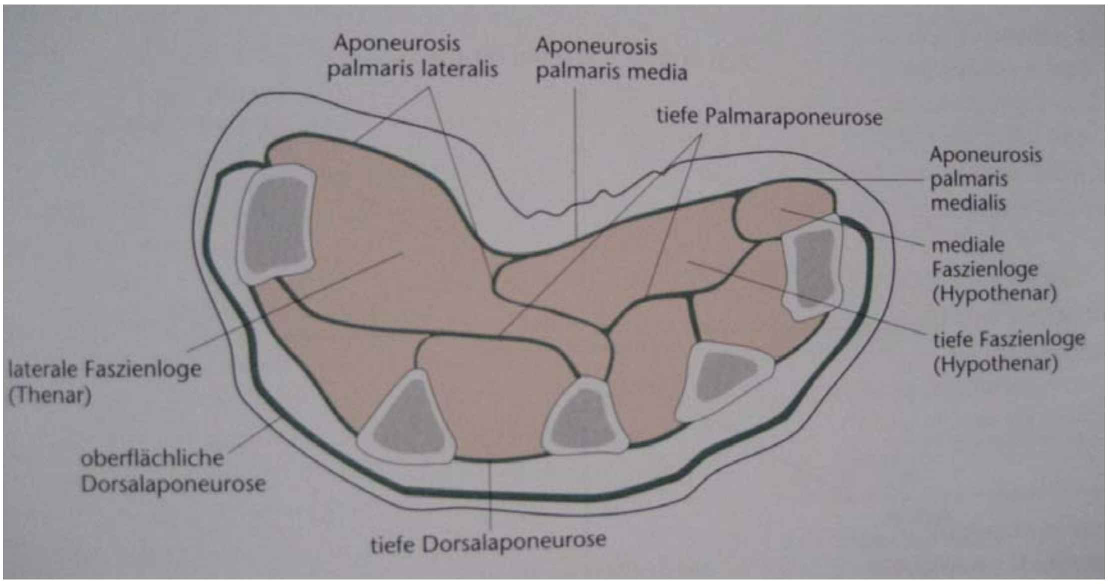


Figure 7: Cross-section through the hand, showing the different aponeurosis (Paoletti 2001, 39)

The superficial dorsal aponeurosis is thin and covers the tendons of the extensors. It is a continuation of the retinaculum extensorum, is connected to the tendons of the extensors, and inserts on the finger bones (phalanges). On the side it is fixed to the first and fifth metacarpal.

The deep dorsal aponeurosis is very thin and covers the dorsal side of the dorsal interosseal muscles.

The superficial palmar aponeurosis consists of three segments:

- a medial segment, the Aponeurosis palmaris media, the actual palmar aponeurosis
- two lateral parts, which cover the balls of the thumb and little finger (thenar and hypothenar)

The medial aponeurosis has the form of a triangle, the base approximately along the origins of the four fingers, and the top is the continuation of the fascia antebrachii and the retinaculum flexorum.

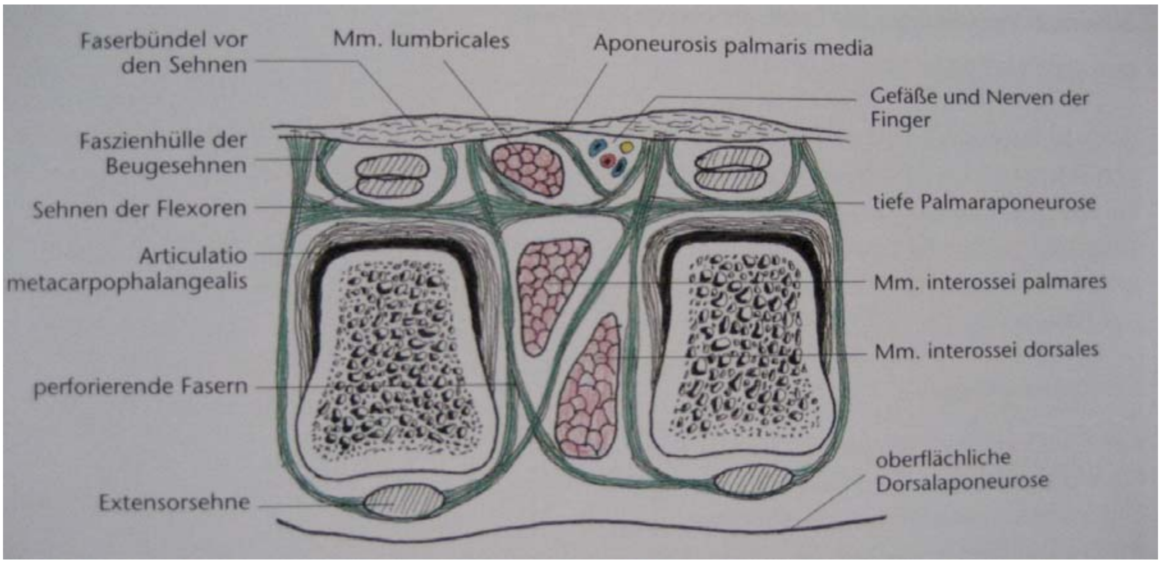


Figure 8: Middle- and deep Palmaraponeurosis (Paoletti 2001, 39)

Proximally the aponuerosis becomes the tendon of the M. palmaris longus, which inserts on the aponeurosis. This tough connective tissue plate lies directly below the skin with which it is connected by short fibres. These fibres can be long and reach from the lower third of the aponeurosis to the creases between the fingers. When they are shortened, they cause shrinkage of the palmar aponeurosis, as seen in patients with Dupuytren's contracture (Paoletti 2001, 39).

Several climbers in my study had beginning signs of Dyputren's contracture, which made it even more obvious that the focus of my work should be the fascia.
The medial palmar aponeurosis covers the tendons of the flexors, the vessels and nerves of the inner hand and reaches the aponeuroses of the thenar and hypothenar. It continues up the fingers, in form of the tendon sheaths of the flexor tendons, inserting on the phalanges.

The medial palmar aponeurosis consists of longitudinal and transversal fibres. The longitudinal fibres can be viewed as the continuation of the retinaculum flexorum and the tendon of the M. palmaris longus. They reach the MCP joints distally and insert there on the four fingers with eight tongue-shaped endings, two at each finger. They are fixed on the lateral side of the proximal phalanx and represent the distal ending of the superficial fascia of the upper extremity.

On either side of the medial palmar aponeurosis, thinner fascias that cover the thenar and hypothenar can be found. The lateral aponeurosis begins on the scaphoid, trapezium and the lateral side of the first metacarpal bone. It then passes between the muscles of the thenar, to fixes onto the anterior part of the third metacarpal bone. The medial aponeurosis inserts on the pisiform bone as well as on the inner/anterior side of the fifth metacarpal bone. The deep palmar aponeurosis continues proximal into the fibrous structures of the wrist bones and ends distally at the MCP joints with thickenings, the profound metacarpal ligaments (Paoletti, 2001).

4 Biomechanical Investigation of the Fingers while Rock Climbing

Burtscher and Jenny (1987, 20) tried to show the forces involved in the various grips using representative examples (in figures 9 and 10).

According to Hochholzer et al.(1999, 39), the main reason for painful swelling of the DIP and PIP as well as for inflammation of the flexor tendon sheaths is holding grips with the fingers bent as represented in figure 10. An extreme variant of this situation would be using the fingertips directly. This position is almost never used, however, because it is extremely painful.

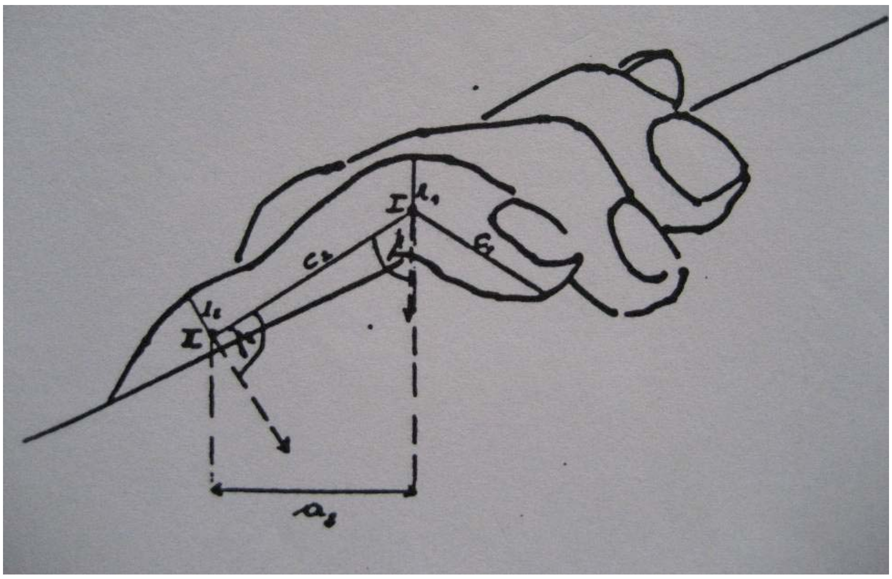


Figure 9: Hanging fingers with slightly flexed DIP joints (Burtscher/Jenny 1987, 20)

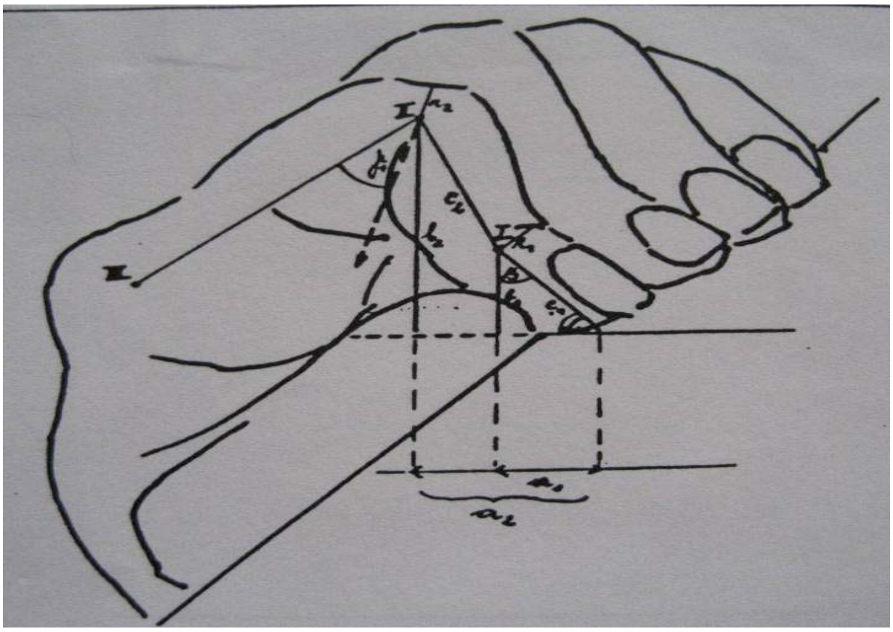


Figure 10: Bent fingers with hyper-extended DIP joints (Burtscher/Jenny 1987, 20)

4.1 Torque in the Proximal and Distal Finger Joints

In the examples shown above, it was assumed that each finger exerted 120N on the ridge. For the sake of simplicity, the frictional forces between skin and the surface and the resistance due to the annular ligaments were ignored. The torque (_) in the PIP and DIP joints is the product of the force (F) and the axis of rotation (r).

_ = r * F

4.2 Transfer of Forces in the Flexor Tendon in the proximal interphalangeal joint

The torque has to be transferred in the DIP. The resulting force on the joint can be calculated with help from the normalized distance and the angle function (Scherer 1994, 13). Based on calculations of various angles, it becomes clear that the transferred force is higher as the angle _1 decreases.

When grasping a positive grip (figure 9), the distance between the line of action and the pivot is small (1-3mm).

Sloper grips are held with fingers bent as seen in figure 10 allowing the friction between skin and the surface to hold. In this case, the distance is greater, and the vector is larger and the transferred force in the flexor tendon at the PIP joint works out to 736N (Burtscher/Jenny, 1987)!

4.3 Implications for Sportclimbing

The forces as calculated by Burtscher and Jenny (1987, 20) represent the "normal" situation in extreme sport climbing. Often the forces can be even higher. In dynamic climbing or when a foot slips off a hold and the climber subsequently has to hold on with only one hand, the forces can be well above the limits of the tendons, cartilage, and ligaments.

The annular ligaments are subjected to very high forces due to the high amount of transferred force in the flexor tendons. Depending on the angle _1, these forces can reach 700N when the fingers are bent. According to Yamada (1970, 56), ligaments do not tolerate a high amount of force (about $5N/mm^2$). Thus, we can conclude that this is a major contributing factor to why annular ligament injuries are so common in sport climbers.

The least taxing of the grips are when all the fingertips are equally loaded or when a larger ledge is griped with the middle and end phalanx. In this case, the joint are in a middle position: they are neither hyper-extended nor in an extremely flexed position. The flexor tendons do not experience a large amount of transferred force that would over-proportionately burden the annular ligaments.

If the wrist joint is slightly hyper-extended, the forces in the flexor tendons reach an optimum. From a medical standpoint, this is the most favourable position. Interestingly, this is position used by most monkey species (Hochholzer/Schöffl, 2001).

Even after a comprehensive literature search into the impacts on the passive structures, only a few studies have been found. The calculations are mostly based on theoretical models, like the one of Burtscher and Jenny (1987). Some of the key assumptions are:

- The body weight is equally balanced on all fingers
- the angle of the interphalangeal joints is equal on all fingers
- the finger geometry is estimated

Alternatively, single structures, like the A2 annular ligament, were tested (Schweizer 1999). But also the study of Quaine et al. (2003) was only done under non climbing specific impacts (Allgäuer 2006, 49).

5 Treatment Methods

The climbers in the study group were all treated with the general osteopathic methods of the principles of the Vienna School of Osteopathy (WSO).
Osteopathy is a manual technique used to restore the life-mechanism through harmonizing the structures, soft tissues and body liquids, to return the patient to his physiological and psychological potential with the help of exact adjustment techniques (Ligner 1999, 1).

According to the principles of the Fascia-Torsions-Model, Typaldos states that an injury affects the connective-tissues of the support and carrier body like ligaments, tendons and retinaculi and results in mechanical dysfunctions. Orthopathic medicine is not only a new diagnostic concept but also a treatment method which can correct fascial torsions and result in positive healing results (Typaldos 1999, 15).
When examining the climbers with general osteopathic methods, very often a compressed thoracic spine and blocked costo-vertebral joints were found. Hochholzer finds that the typical climbing position places the most demands on the ventral muscle chain of the trunk and the flexor muscles of the arms and this can lead to shortenings of theses muscles (Hochholzer/Schöffl 2001, 82).
Perhaps this permanent hypertension in the biceps, pectoral, abdominal, and latissimus dorsi muscles are the reason for osteopathic lesions in the thoracic spine.

5.1 *Treatment of Fascia Dystorsions*

5.1.1 The function of the fascia

Fascias have many different functions in the human body. The connective tissue makes a connection without a gap between all different parts of the body and the organs.
It plays an important roll as a support-, carrier- and protection system (Paoletti 2001, 146). The muscle system cannot work without its proper function and is more likely to get injured. The fascias are also responsible for the stability of all the joints and keep them functional. The muscular system can be seen as the motor for the joint movements, but is controlled by the mechanics of the fascia itself. They are also the carrier structure of the nervous, circulatory and lymphatic systems.
Another very important role, especially in extreme sports where enormous forces produce stress on soft tissues, is the protective function of the fascias. If loads are too heavy or stress is too high, the fascias also work like shock-absorbers. The macromolecular network structure of the proteoglycanes works actively to hold the tissues together during mechanical demands.
The proteoglycanes can transform themselves during intense and often repeated impacts into a viscous-elastic fluid which then acts like a lubricant (Paoletti 2001).

5.1.2 Diagnosis of the Fascia distortion

Every injury can be apportioned into one or several different fascia distortions.
For the treatment of a lesion, orthopathic medicine first describes the distortion and corrects it with the appropriate technique (Typaldos 1999, 23).
In this study the focus was mostly on fascia distortions in the fingers, hand and arm area.

5.1.3 Triggerband and Triggerband Techniques

Anatomical changes in the fascias where the single fibres become twisted, separated or ruptured are called triggerbands. The patient with this kind of lesion describes his pain as burning or pulling along the course of the triggerband (Typaldos 1999, 29).His body language shows exactly the length and the location of the triggerband.

Aim of the therapy in these cases is to correct the twisted fibres with the thumb and close them again.

There are two kinds of triggerbands: acute and chronic. An acute triggerband can heal spontaneously, slowly or not at all if the causal stresses are still there. This means that training or climbing with an injured finger is detrimental for the healing process. On the other hand, the treatment of a chronic triggerband is more difficult. Several sessions are necessary to break up adhesions; the treatment can be more painful and bruises are often seen.

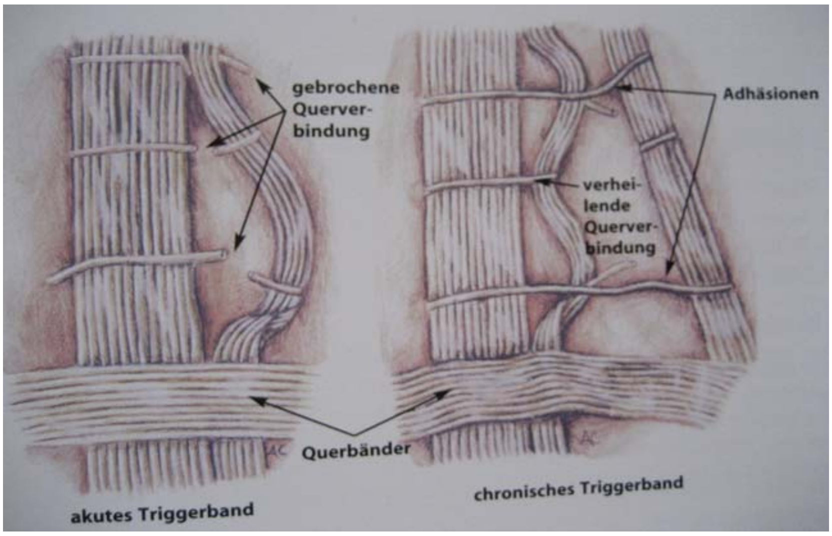


Figure 11: Acute and chronic Triggerbands (Typaldos 1999, 33)

Figure 9: Treatment of a triggerband in a finger

5.1.4 Folding Distortions and Folding Techniques

Fascias close to joints can be deformed by either traction or compression forces. Typaldos calls these kinds of lesions Folding Distortions (Typaldos 1999, 47).
These three-dimensional injuries at the fascia level cause pain deep in the joint and reduce the capability of the fascias to protect the joint against pulling- or pushing forces. Sportclimbing with its dynamic pulling and twisting forces on the fingers can lead to "unfolding" distortions. "Unfolding torsions occur if a fascia are unfolded and twisted by a pulling and twisting force and then folded again into this position" (Typaldos 1999, 47). The treatment of these lesions should never be painful. First, the twisted fascia is unfolded and unwound with some gentle pulling. Afterwards, traction is applied to help replace the fascia into the normal position again.

Figure 10: Treatment of a Folding Distorsion of a PIP Joint

5.1.5 Cylinder torsions and Cylinder techniques

Traction in combination with a twist can cause a symptom called cylinder torsion. Dynamic climbing which is often necessary in very difficult routes can lead to this kind of fascial injuries. In this case, the spiral windings of the circular fascias become hooked onto each other and lose their elasticity and therefore their ability to absorb impacts.

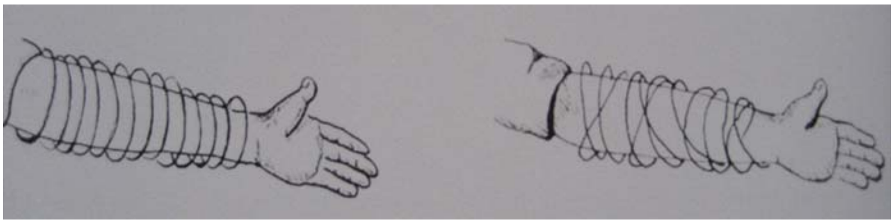


Figure 11: Normal and twisted cylinder torsion (Typaldos 1999, 60)

The double-thumb-technique is used to correct localised distortions. The deep fibres are parallel to the bone and best treated with this technique. The thumbs are placed on both sides of the tight tissue and then brought under traction. The traction is held until a release in the tissue is recognized. After the deeper layer has been corrected, the superficial layer has to be released as well. The traction of the thumbs is the same, but this time the direction is different. To unwind this fibres which envelope the extremities at a 90 degree angle, the direction of the traction is parallel to the bone. Also in this case the stretch is continued as long till a release of the tissue is palpable.
When working with this kind of technique, best results are achieved if several areas of the extremity are treated (Typaldos 1999, 61).

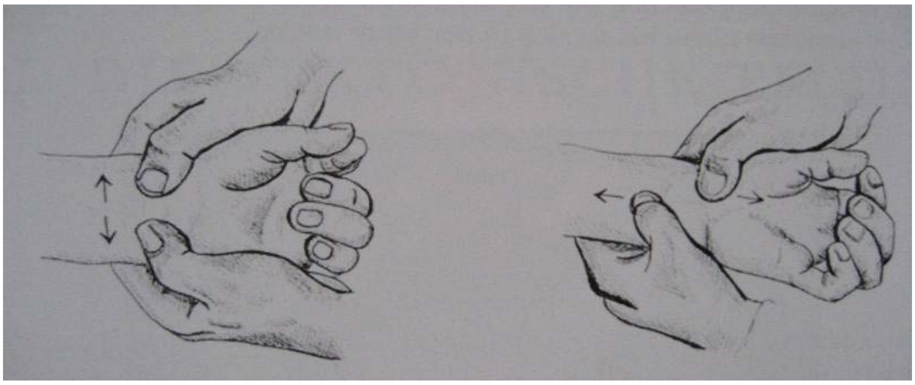


Figure 12: Double-thumb-technique for the deep (left) and superficial (right) layer of a cylinder torsion (Typaldos 1999, 61)

5.1.6 Fascia stretching exercises

Güllich has found that the training of the flexibility in climbing has been neglected in favour of the muscle training. But "more elastic muscles and tendons can burden more weight than untrained ones. Therefore the risk of injuries is reduced, while the efficiency

gains. This can be said especially for the fingers, the most important tool of any climber." (Güllich/Kubin 1986, 142).
Güllich and Hochholzer (2001, 121) recommend daily flexibility training, especially after climbing or specific training.
There are several possibilities to stretch the forearm muscles and fascias, a classic example can be seen in figure 16.
The climber kneels down, the fingers are pointing backwards towards the knees, and the palms are laid flat on the ground. A gentle moving backwards of the upper body puts a stretch on the volar side of the forearm, and should be held for at least 30 seconds.

Figure 13: Stretching of the finger-flexors and fascias

5.2 Treatment of the Thoracic Spine

The bony thorax consists of 12 thoracic vertebrae and 12 pairs of ribs, the sternum and its connecting muscles and ligaments. Dysfunctions of the thoracic spine affect the rib function and vice versa. With dysfunctions in this area, the vertebrae usually have to be treated before the ribs (Greenman 1998, 231).
A somatic dysfunction is defined as a disturbed or changed function of parts of the musculoskeletal system and the connections within it. Bones, joints, and myofascial

structures, but also lymphatic and neural elements belong to it. Repeated or dynamic overloads can lead to shortening of the muscle and as a result in hypo-flexible or blocked joints (Sammut/Searle-Barnes 2000, 90).
The typical climbing position, with an extension of the cervical spine (looking up while climbing!) and a kyphosis of the thoracic spine may also be a reason for somatic lesions in the upper thoracic region.
At TH1, the cervical lordosis changes into the thoracic kyphosis. Greenman has found that dysfunctions of this vertebra have an important influence on the functional capacity of the upper thoracic opening and its connective structures (Greenmann 1998, 231).

5.2.1 Diagnosis of the thoracic spine

Because of the costo-vertebral and costo-transverse joints, the mobility of the thoracic spine is limited. Functionally, the first three thoracic vertebrae belong to the cervical spine: this is the reason that the lateral flexion and rotation in these segments are always to the same side. With the help of a precise diagnosis, dysfunctions of one segment (non-neutral type 2) and group-dysfunctions over several segments can be found (neutral type 1).
At the upper thoracic spine (TH1 to TH5) the movement can be checked with a flexion and extension of the head. The osteopath palpates the transverse process on both sides.
If the dysfunctional vertebra is in extension, rotation and lateral flexion (ERS), the transverse process of the affected side will become more prominent while the patient bend the head forward (in flexion). If the dysfunctional vertebrae are in flexion, rotation and lateral flexion (FRS), the transverse process of the affected side will become more prominent while doing a head extension. If there is a neutral group dysfunction of several vertebrae, the transverse processes are more prominent on one side. During a flexion- or extension of the head, these transverse processes will become more or less prominent but never symmetrical (Greenman 1998, 232).

5.2.2 Manipulation of TH1

Greenman recommends the following manipulation to correct a dysfunction of TH1 (Greenman 1998, 249). For example, an FRLle dysfunction (Flexion, rotation and lateral flexion to the left) of TH1 can be corrected with:

1. The patient is lying prone; the osteopath is standing at the end of the couch (figure 17).
2. The hands of the osteopath are placed on the right of the chin and rotate the face to the right (figure 18).
3. The osteopath puts his right pisiform bone on the right transverse process of TH2 (lower segment) (figure 19).
4. The osteopath gives a ventral impulse with his right hand. With this movement he rotates TH2 to the left side into an extension, which results in a closing of the right vertebral joint. The left hand is used to stabilise the head and neck.
5. Then the position of TH1 is checked again.

Figure 14: Manipulation of TH1

Figure 15: Manipulation of TH1

Figure 169: Manipulation of TH1

5.2.3 Manipulation of TH3-TH5

For dysfunctions in this area, Greenman uses a manipulation technique which also can be helpful for problem areas in the lower thoracic spine (Greenman 1998, 254).
In this study, the following technique was used for a group extension lesion of TH3-TH5:

1. The patient is lying on his back; the osteopath is standing next to him.
2. The patient crosses both arms in front of his chest, to be used as a lever.
3. The osteopath uses his hand as the fulcrum, placing it under the trunk of the patient on TH5.
4. The cranial hand of the therapist flexes the head of the patient till TH4.
5. The osteopath gives an impulse with his body weight over the lever against the fulcrum and at the same time slightly increases the flexion of the patient (figure 20).
6. The placement of TH3-TH5 is checked once again.

Figure 20: Manipulation of TH3-TH5

6 Examination Procedure

6.1 Study design

This was a controlled study where the patient was allowed to choose the treatment method. There were two groups, a study and a control group.
The advantage of the possibility that each patient could choose in which group he wanted to was definitely an ethnical one. It gives the patient the feeling of being an active part of the decision. This can have a positive influence on the outcome of the therapy. While this is an advantage for the individual patient, it is also a disadvantage for scientific reasons. The patients were not assigned randomly to the groups, so there is more possibility for bias due to the considerations the individual patients made when choosing their treatment and in how open they are to osteopathic therapy. A blind study would be very difficult to run with such therapy, as a placebo treatment would be very difficult to create and control.

Notices were put up at indoor and outdoor climbing areas in and around Innsbruck to find climbers who have had the typical painful climbing fingers for at least 5 weeks.

Even though the study duration was more than 2 years, only 9 climbers could be found for the control- and 14 climbers for the study group.

All these climbers were examined with ultrasound (Entrance Test) by Dr. Klauser (Golden Standard). They were informed about the ultrasound results and what kind of therapy she as a doctor would recommend:

- break or reduction of training and climbing (class 1)
- drugs (class 2)
- cortisone injection (class 3)

Within a week after the ultrasound check, the climbers did the pulling test and completed the questionnaire.
I discussed all 3 results of the independent variables (Ultrasound, questionnaire and pulling test) with them and explained what I, the osteopath, could do for them.
Once the patients had received these two sets of information, one from a traditional doctor and the other from an osteopath, they decided freely what kind of therapy they wanted to have.
Two groups were created:

- Study Group (n = 14)
- Control Group (n = 9) with 3 different therapy classes

An osteopathic treatment consisted of three sessions of 45-60 minutes, each with a treatment concept specifically designed for the individual patient. The second treatment was around one week after the first, the third 3-4 weeks after the second.
6-8 weeks after the entrance ultrasound test, both groups had a control ultrasound examination and filled out a second questionnaire and redid the pulling test.

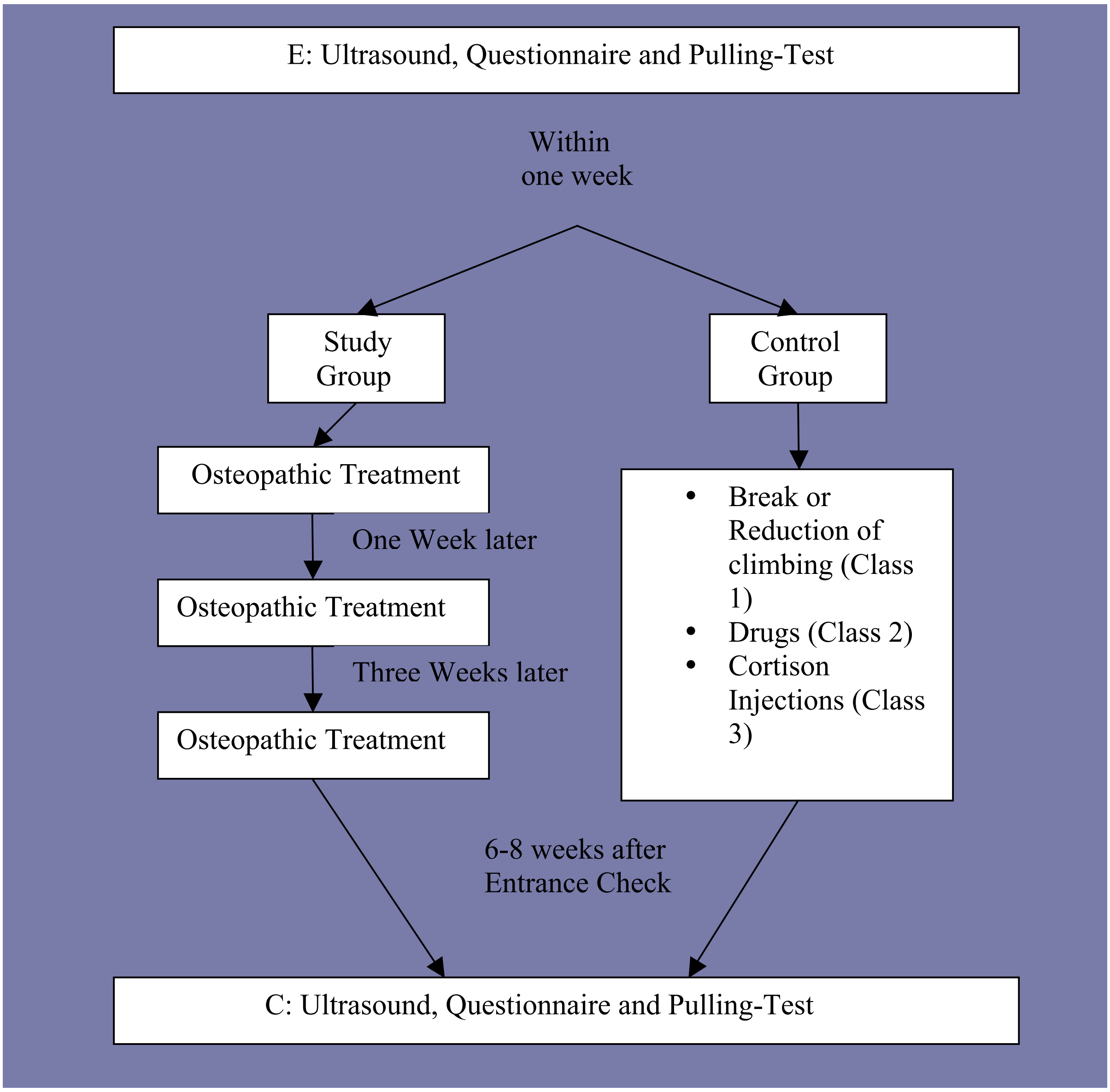


Figure 21: Study Design

6.2 Inclusion criteria

Rock climbers (male and female) between the ages of 15-50 years old, who have been had pain in their fingers for at least 5 weeks from climbing and must have been climbers for at least 3 years to make sure they have some climbing and training experience.
They had to have a typical climbing injury, diagnosed by ultrasound (gold standard).
Normal Climbing frequency must be at least 1x/week.

6.3 Exclusion criteria

- Operation in the painful area
- Pain not from climbing

6.4 Pulling Test

6.4.1 Examination Method

A climbing-specific pulling test demonstrates with how much force the climber can tolerate with the injured finger, before having any pain.
This result was compared with the ultrasound and the questionnaire.
We used a Macro-Scale from Pesola with a capacity of 0 to 20 kg and a drag-pointer. The division of this scale is 200 g. The scale was gauged several times with 5 and 15 kg.
The scale is fixed on a height-level changeable machine. A sling with a broad 1.5 cm long was fitted on the bottom of the scale.
The climber had to stand below the scale with feet spread hip-wide, and with his arm 90° abducted, 45° anteverted, and 90° flexed in the elbow. The injured finger was placed in the sling up to the skin fold of the DIP joint, and then pulled slowly down, a movement very similar to climbing. As soon as he felt uncomfortable or noticed any pain, he stopped pulling immediately.
The maximum weight can be seen with the drag-pointer and was recorded.
If a patient pulled with more power than 20 kg, this could not be measured and was marked as 20 kg.
The pulling test was done in the two different finger positions which are the most frequently used ways to hold grips in climbing. In both finger positions every climber was asked to do a trial test first, afterwards the real test was done.

6.4.2 Pulling Test 1: Hanging finger with a slightly flexed DIP joint

The Pulling Test 1 was performed in a hanging finger position with a slightly flexed DIP joint, which is also the finger position used for positive grips.
On the following two pictures this finger position can be seen.

Figure 17: Pulling Test 1

Figure 23: Close-Up of Pulling Test 1

Holding a grip this way puts less stress on the joints, ligaments and tendons (Hochholzer/Schöffl 2001; Burtscher/Jenny 1987) and should be preferred to the finger position of Pulling Test 2.

6.4.3 Pulling Test 2: Bent finger with a hyper-extended DIP joint

The finger position which is shown on the following picture is mostly used for very small holds. It should be avoided while climbing if possible, due to the high stress on several structures of the finger (Hochholzer/Schöffl 2001). The Pulling Test 2 was performed in this finger position.

Figure 18: Close-Up of Pulling Test 2

When the entrance pulley test was administered, 4 climbers of the research group and 3 climbers of the control group were not climbing at all. However, even these patients were already testing small holds to see with how much force they can pull without having any pain.
This means that the pulling test is not an unknown or unreasonable impact for the injured finger for any of the participants.

6.5 Questionnaire

The questionnaire was based on the considerations of Schöffl et al. (2004) and Burtscher et al. (1987)
2 different questionnaires were created. The first was handed out at the time of the first pulley test, the second at the time of the control pulley test. (See appendix)
Following facts are asked:

- Name
- Date of birth
- Climbing Years
- Most difficult route ever climbed red-point
- Normal Climbing frequency/week
- Date of Injury
- Current maximum climbing level
- Current Climbing frequency/week

Additionally, the date and the results of the ultrasound check and the results of the pulling test are noted.

6-8 weeks later, another questionnaire was handed out; again the

- momentary maximum climbing level and
- climbing frequency/week

were asked. The control ultrasound results and the outcome of the control pulling test were noted.

6.6 Ultrasound

In comparison to a MRI (Magnetic resonance tomography) or CT (computer tomography) examination, US is much cheaper and less radiation intensive. It can help to evaluate the therapeutic management. (Klauser et al. 2000, 74). The US was done with a high-resolution transducer operating at 12 MHZ (15L8 Acuson Sequioa; Siemens Medical System-Ultrasound Group, Issaquah, WA) with a Doppler frequency between 6 to 9 MHZ. Dr. Klauser used a gel standoff pad (Sonar Aid, Geistlich Pharma, Wolhusen, Switzerland) in all cases. Each examination was stored digitally on a hard disc. US was performed on the hand in supinated position, from the heads of the metacarpals to the distal phalanges in both transverse and longitudinal planes. The tendon phalanx-distance (TP) measurements were performed in the longitudinal plane. First, US measurement was performed on the extended fingers in the resting position followed by examination during actively forced flexion: approximately 10° in the distal interphalangeal joint (DIP), 40° in the proximal interphalangeal joint (PIP), with extension of the metacarpal (MCP) joint. These

measurements of the protrusion of the flexor tendon serve as a measure of tendon bowstringing which indicates a lesion of the annular pulley system.
In addition to the TP-distance, the gliding ability of the superficial and deep digital flexor tendon sheaths during active and passive motion are visualised and help to diagnose tendovaginitis. Furthermore, the regions of the tendon as well as the PIP and DIP joints were evaluated for the presence of inflammatory or degenerative changes, such as cysts, excessive fibrous tissue and fluid collections. Measurements were performed in both the axial and longitudinal planes.

6.6.1 Ultrasound Diagnosis

With the help of the US examination, all participants of the study were put in three different groups depending on the US diagnosis:

- Group A: Joint related problems (MCP, PIP or DIP)
- Group B: Annular Pulley System problems
- Group C: Tendovaginitis

6.6.2 Ultrasound Seriousness Classification

Each of these groups was classified into three different levels (0, 1, and 2) depending on the severity of the problem. The classification was done by Dr. Klauser and described as following:

- Level 0: Normal or close to normal (>0,8mm changes)
- Level 1: Thickness (>1mm changes) or Hyperaemia
- Level 2: Thickness and Hyperaemia

These levels are compared at the entrance and control US check, and will be described as the US Diagnosed Healing-process.

6.7 Assessment

6.7.1 Assessment methods

For the facts evaluation the statistic- and facts analysis program Win STAT version 2005.1 was used. The process, evaluation and representation are done with the help of the Win STAT and Microsoft Excel programmes 2002.
To allow for counting of the climbing difficulty, which was evaluated in the most popular and now more and more world wide used French grading system, the number was transformed into decimal numbers.
The evaluation will be done in two different blocks:

- Descriptive Statistic:
  The data were checked for mean, confidence, standard error, and standard deviation
- Evaluative Statistic:
  The relationships between the data groups were calculated and the hypotheses were tested.

6.8 Results

6.8.1 Descriptive Statistic

6.8.1.1 Ultrasound Diagnosis

	frequency	%	cumulative %
Control Group	*9*	*39,13*	*39,13*
annular pulley injuries	6	66,67	66,67
joint releated problems	1	11,11	77,78
tendovaginitis	2	22,22	100,00
Study Group	*14*	*60,87*	*100,00*
annular pulley injuries	7	50,00	50,00
joint releated problems	4	28,57	78,57
tendovaginitis	3	21,43	100,00

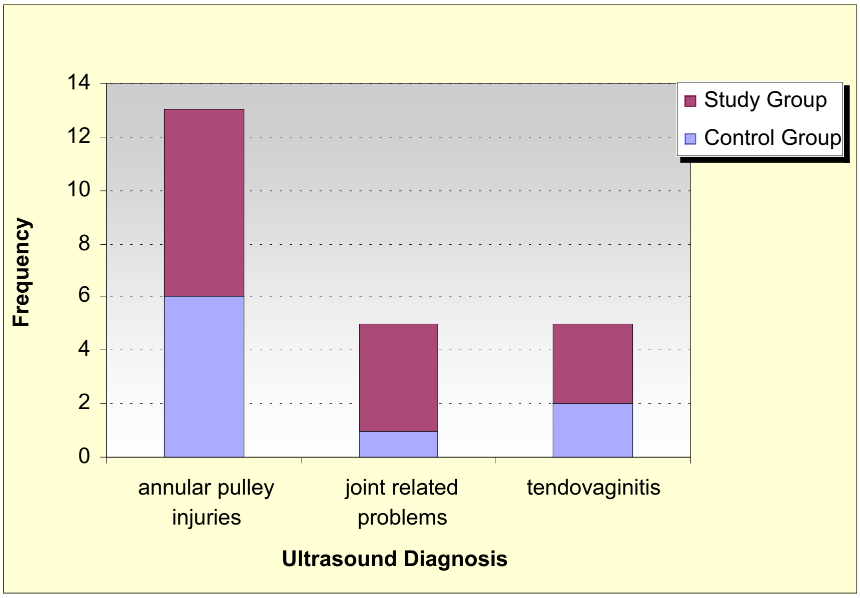


Table 1: Ultrasound Diagnosis Study- and Control Group

In the study, 23 climbers were tested. With the help of the ultrasound examination, the 14 climbers of the study group were divided into 7 annular pulley injuries, 4 joint related problems, and 3 competitors with a tendovaginitis (2 in the control group). The control group consisted of 9 patients: 6 with annular pulley injuries, one with joint related problems and 2 with tendovaginitis.

If we look at which finger was injured, we had 7 middle fingers on the right hand and 2 on the left hand, 5 affected ring-fingers on the right hand, 8 left ring fingers, and one painful right thumb.

6.8.1.2 Climbing Years

	N	mean	confidence 0,95	Std.error	Std.deviation
Control Group	9,00	13,89	6,27	2,72	8,16
Study Group	14,00	7,64	2,24	1,04	3,88
total sample	23,00	10,09	2,83	1,36	6,54

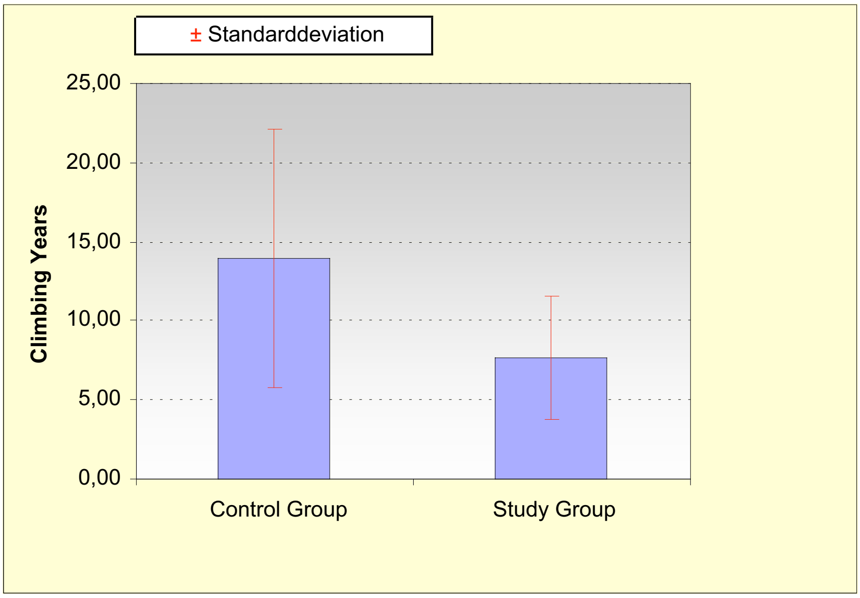


Table 2: Climbing Years

The years of climbing experience varies from 3 to a maximum of 25 years. The mean of the control group with 13.89 is almost double of the study group with 7.64 years. The confidence with 95% is in the Control Group with 6.27, and in the in the Study Group with 2.24 also much higher.
The mean age of the climbers is 30 years in the study group and 33 years in the control group. This means that the climbers in the control group started climbing with a younger age with a significant level.

6.8.1.3 Red-point Mean

	N	mean	confidence 95%	Std.error	Std.deviation
Control Group	9,00	7,83	0,81	0,35	1,05
Study Group	14,00	7,62	0,46	0,21	0,79
total sample	23,00	7,70	0,38	0,18	0,89

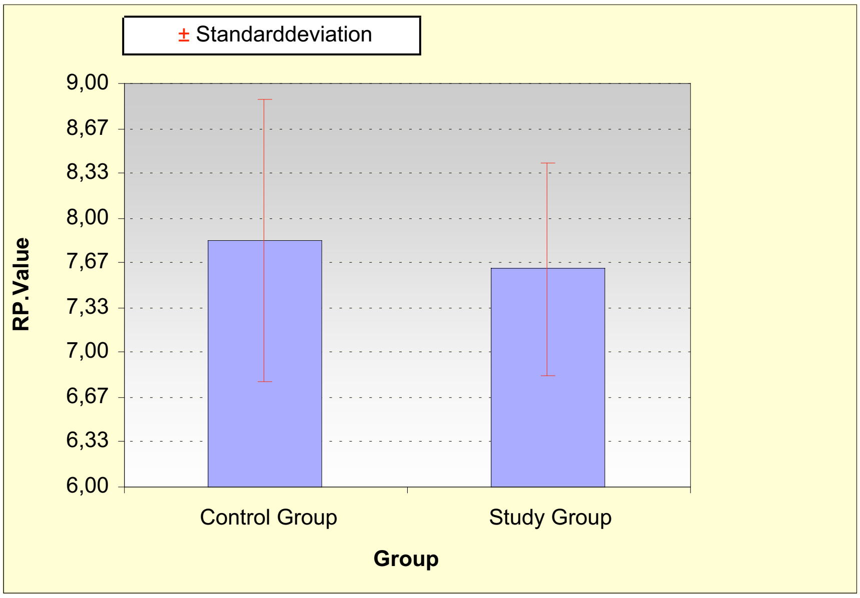


Table3: Maximum Red-Point difficulty

The maximum red-point difficulty was 7.83 (7c+) and the standard deviation 1.05 for the control group is pretty similar to the Study Group with 7.62 (7c) and a Standard deviation of 0.79. A t-test showed no significant result.

6.8.1.4 Red-Point level: Maximum, Entrance and Control Test

	n	mean	confidence 0,95	Std.error	Std.deviation
Study Group RP	14,00	7,62	0,46	0,21	0,79
Control Group RP	9,00	7,83	0,81	0,35	1,05
Study Group E. RP	10,00	6,98	0,55	0,24	0,76
Control Group E. RP	6,00	7,31	0,92	0,36	0,87
Study Group C. RP	14,00	7,13	0,41	0,19	0,70
Control Group C. RP	8,00	7,31	0,79	0,33	0,94

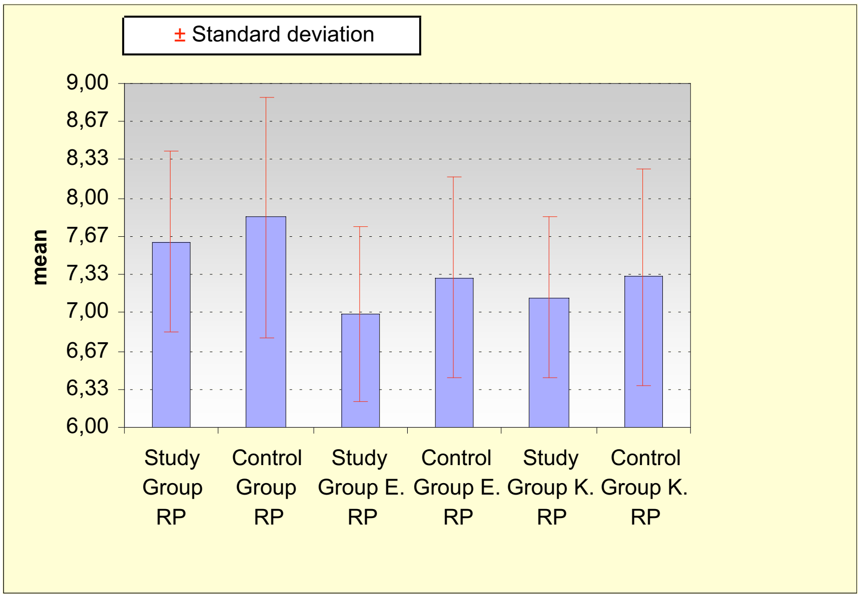


Table 4: Red-point level: Maximum, at the Entrance and Control Test

First the maximum red-point level was asked as well as the red-point level at the time of the entrance- and control test was evaluated.

At the time of the entrance test, 4 people in the Study Group did not go climbing at all, and the red-point level was at 6.98 (7a). In the Control Group, we had 6 climbers with a mean red-point level of 7.31 (7b). At the control test, the red-point level stayed the same with 7.31 (7b), but with 8 people already climbing. At the time of the control test, all members of the study group were already climbing again and the red-point level has risen to 7.13 (7a+).

6.8.2 Evaluative Statistics

6.8.2.1 Red-Point level compared with the Ultrasound diagnosis

	n	mean	confidence 0,95	Std.error	Std.deviation
annular pulley injuries	13,00	7,65	0,47	0,21	0,77
joint related problems	5,00	7,70	1,47	0,53	1,19
tendovaginitis	5,00	7,83	1,30	0,47	1,05
total sample	23,00	7,70	0,38	0,18	0,89

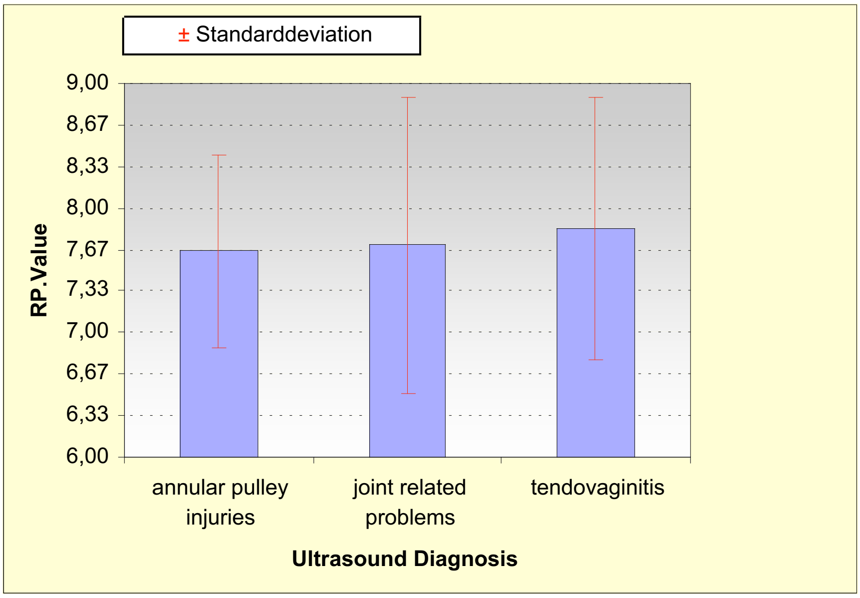


Table 5: Red-point level compared with the US-Diagnosis

In this table it can be seen that the climbing level is very similar and not significant in all three lesion groups with the mean being the highest in the class with the tendovaginitis at 7.83 (7c+), with a confidence of 95% at 1.30, the standard error at 0.47 and the standard error at 1.05.

6.8.2.2 Red-Point level Improvement

	n	mean	confidence	Std.error	Std.deviation
Control Group	6,00	0,19	0,49	0,19	0,46
Study Group	10,00	0,23	0,16	0,07	0,22
total sample	16,00	0,22	0,17	0,08	0,32

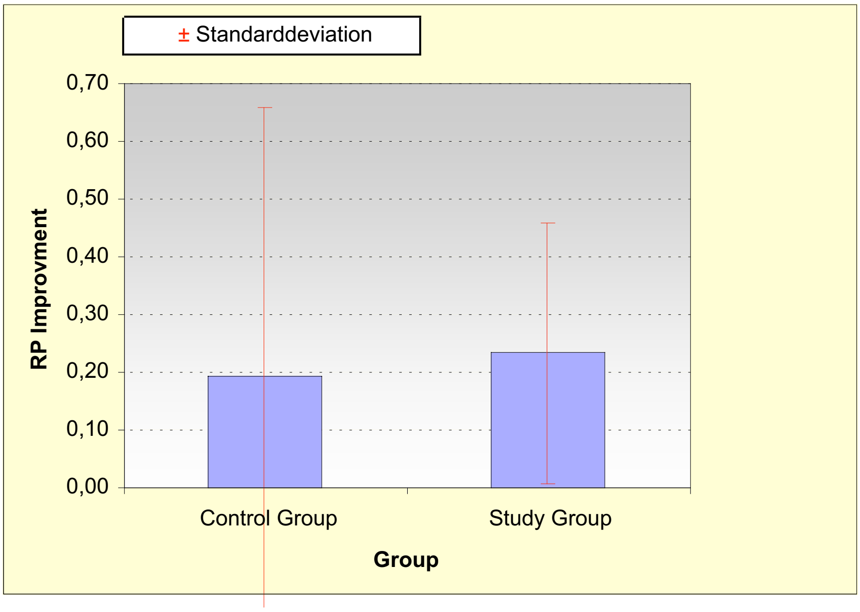


Table 6: Red-point level improvement

If we just take the climbers who were also climbing at the time of the entrance test and compare them with their red-point level at the control test, we find a small improvement in the study group (0.23 compared to 0.19 for the control group). At a confidence of 95% the study group was at 0.16, the control group at 0.49. The standard error in the study group was 0.07 (0.19 in the Control Group) and the standard deviation 0.22 (Study Group) and 0.46 (Control Group).

A T-test for a homogenously paired sample correlation was made with 0.050. The T-test value: 2.146. The result is significant.

6.8.2.3 Ultrasound Improvement arranged after US Diagnosis and Group

	n	mean	confidence 0,95	Std.error	Std.deviation
annular pulley injuries	*13,00*	*1,00*	*0,35*	0,16	0,58
Control Group	6,00	1,33	0,54	0,21	0,52
Study Group	7,00	0,71	0,45	0,18	0,49
joint related problems	*5,00*	*1,40*	*1,11*	0,40	0,89
Control Group	1,00	1,00	----	----	----
Study Group	4,00	1,50	1,59	0,50	1,00

tendovaginitis	*5,00*	*1,00*	*0,88*	0,32	0,71
Control Group	2,00	1,50	5,00	0,50	0,71
Study Group	3,00	0,67	1,43	0,33	0,58
total sample	23,00	1,09	0,29	0,14	0,67

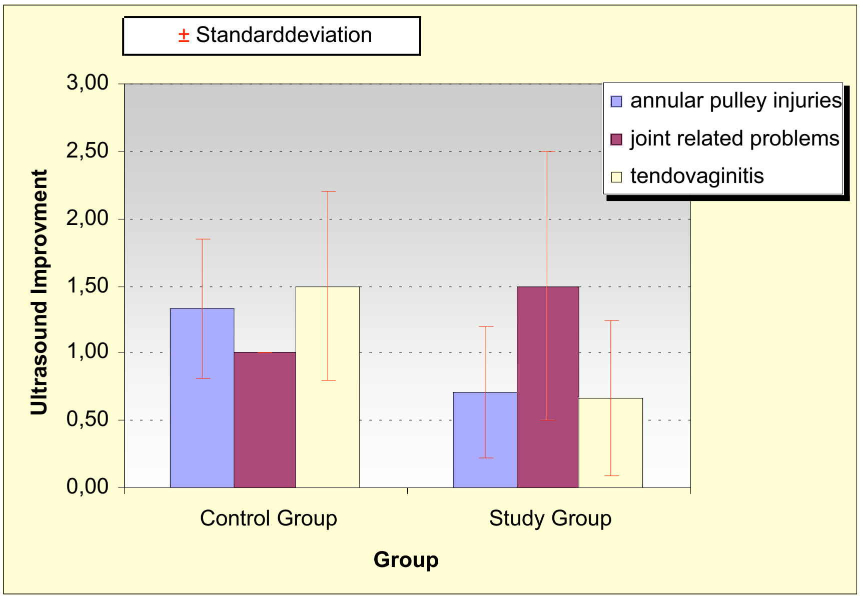


Table6: US Improvement arranged after US Diagnosis and Group

This test was done to see if there was any significant improvement in either the study- or the control group from the view- point of the ultrasound.

Both groups were divided into the three diagnosis classes. Since the class with joint related problems and the class with tendovaginitis in the control group contained only one and two climbers respectively, comparison with the study group is not possible.

However, in the class with the annular pulley lesions we had an improvement from 1.33 in the control group and 0.71 in the study group. With a confidence of 95% the control group was slightly better with 0.54 compared to 0.45. The standard error in this group was 0.21 (0.18 study group) and the standard deviation was 0.52 (0.49 Study Group).

A t-test was done for the annular pulley injuries.

A homogenously paired sample correlation test was made with 0.049. The t-value was 2.212; the result is significant.

6.8.2.4 Red-Point improvement of annular pulley injuries

	n	mean	confidence	Std.error	Std.deviation
cortisone injection	2,00	0,33	3,33	0,33	0,47
osteopathic treatment	4,00	0,38	0,45	0,14	0,28
total sample	6,00	0,36	0,32	0,12	0,31

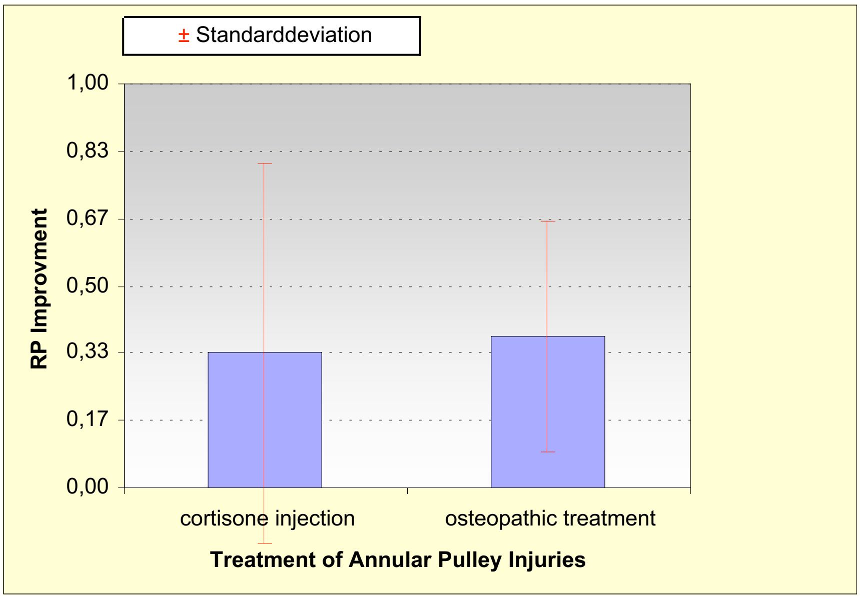


Table 7: Red-Point improvement of annular pulley injuries

This test was done to show how much the Red-Point level of annular pulley injuries improved according to the treatment received. Again, only climbers who were climbing at both the entrance and the control tests were included. A t-test was done and showed for a homogenously paired sample correlation test 0.873, the t-value -0.171 and is not a significant result.

6.8.2.5 Ultrasound improvement sorted after treatment

	n	mean	confidence 0,95	Std.error	Std.deviation
cortisone injection	4,00	1,50	0,92	0,29	0,58
only break or reduction	5,00	1,20	0,56	0,20	0,45
osteopathic treatment	14,00	0,93	0,42	0,20	0,73
total sample	23,00	1,09	0,29	0,14	0,67

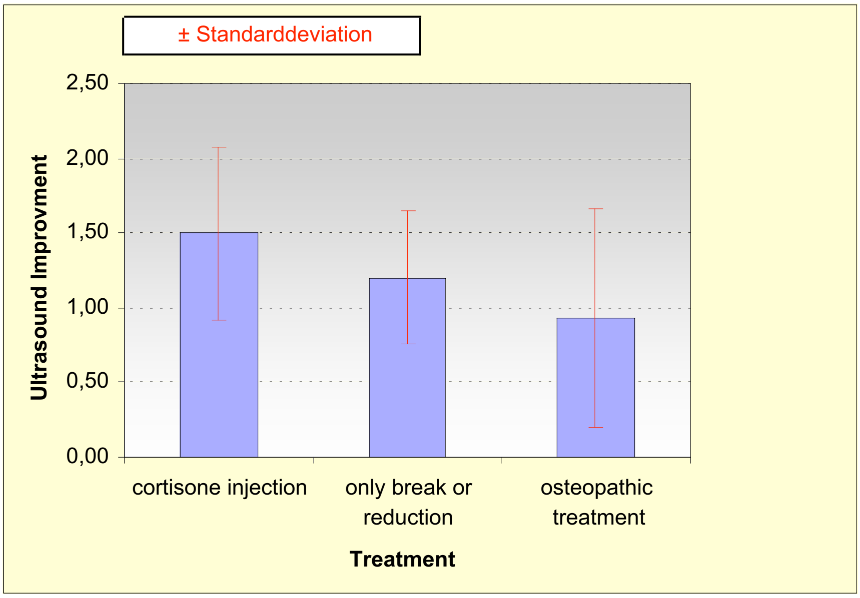


Table 8: Ultrasound improvement sorted after treatment

If we ask for the ultrasound improvement in comparison to the different treatment methods, the class with the cortisone injection had the best mean.

The mean ultrasound improvement in the cortisone group was 1.50 with a standard deviation of 0.58. The group who had only a reduction in training was at 1.20 (Standard deviation 0.45) and the Osteopathic group at 0.93 (Std.dev.0.73).

A homogenously paired sample correlation test between the cortisone group and the osteopathic group showed no significant results.

6.8.2.6 Ultrasound Improvement compared with a climbing reduction

climbing reduction/week	n	mean	confidence 0,95	Std.error	Std.deviaiton
0,00	1,00	1,00	----	----	----
1,00	10,00	1,00	0,58	0,26	0,82
2,00	6,00	1,17	0,43	0,17	0,41
3,00	4,00	1,50	0,92	0,29	0,58
4,00	2,00	0,50	5,00	0,50	0,71
total sample	23,00	1,09	0,29	0,14	0,67

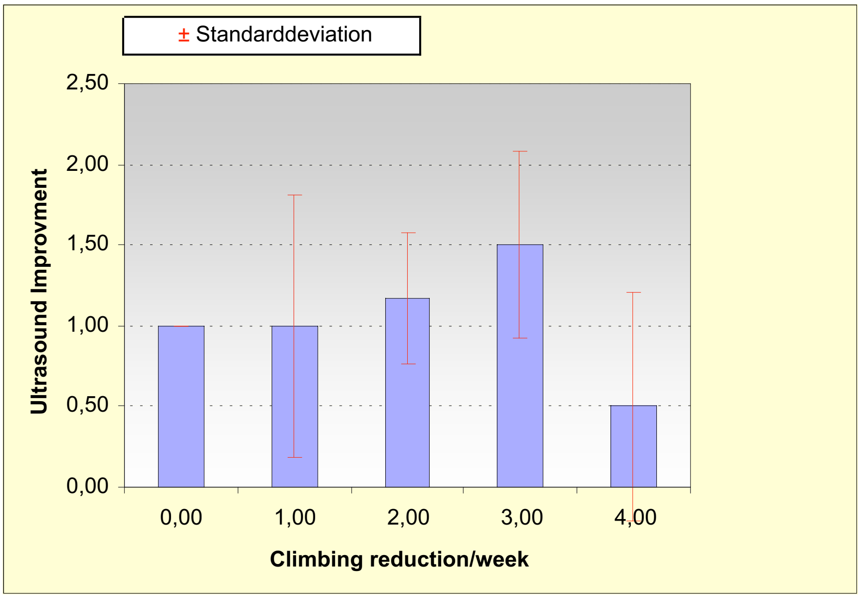


Table 9: Ultrasound improvement compared to climbing reduction per week

Very often climbers complain about their painful fingers but are still doing their normal training routine. Does a climbing reduction have any effect on the injured fingers? We tried to compare a reduction of 1, 2, 3 and 4 times climbing a week (of both groups) with an improvement of the ultrasound outcome.

In the class of two and three fewer climbing sessions per week, an improvement can be seen: 1.17 at two times and 1.50 at three times. The standard deviation here was 0.41 and 0.58, respectively.

The class with 4 times climbing reduction had very little improvement. The reason for this could be the seriousness of the injury. This will be discussed in more detail in the next chapter.

6.8.2.7 Difference Hanging Test

	n	mean	confidence 0,95	Std.error	Std.deviation
Control Group	9,00	1,53	1,90	0,82	2,47
Study Group	14,00	2,43	1,73	0,80	3,00
total sample	23,00	2,08	1,20	0,58	2,78

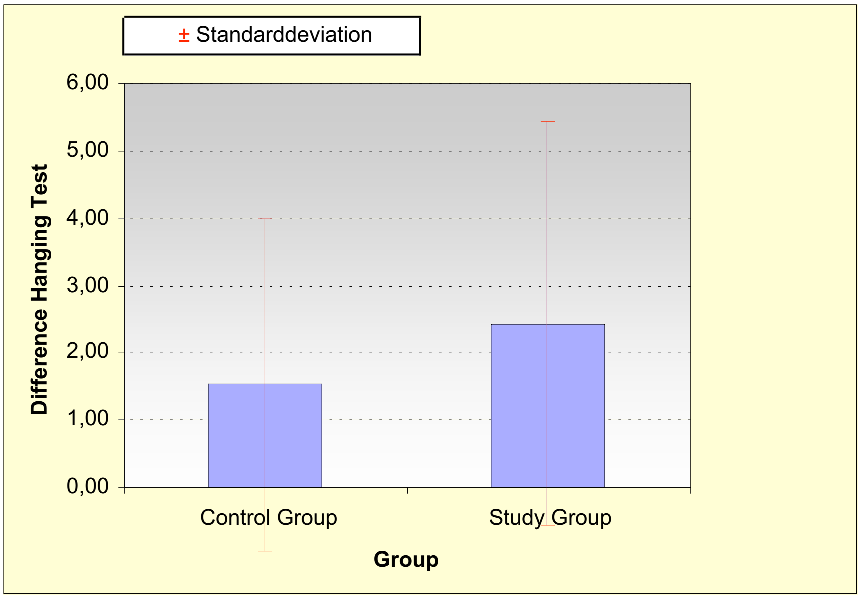


Table 10: Difference Hanging Test

Aside from the ultrasound improvement and the performance level (RP-level), the hanging test was another independent variable.

First we compared the difference between the entrance- and the control test results for both groups. Here the study group received higher values than the control group with a mean of 2.43 kg (1.53 kg Control Group). With a confidence of 95% the Study Group was at 1.73 (1.90 Control Group) the confidence with 95% was 1.73 (C.G. 1.90) the standard error was 0.80 (C.G. 0.82) and the standard deviation 3.00 (C.G. 2.47).

A homogenously paired correlation sample test was at 0.462, the t-value -0.750 and the result not significant.

6.8.2.8 Difference Bent Test

	n	mean	confidence 0,95	Std.error	Std.deviation
Control Group	9,00	5,03	3,49	1,51	4,54
Study Group	14,00	2,38	2,63	1,22	4,55
total sample	23,00	3,42	2,00	0,97	4,63

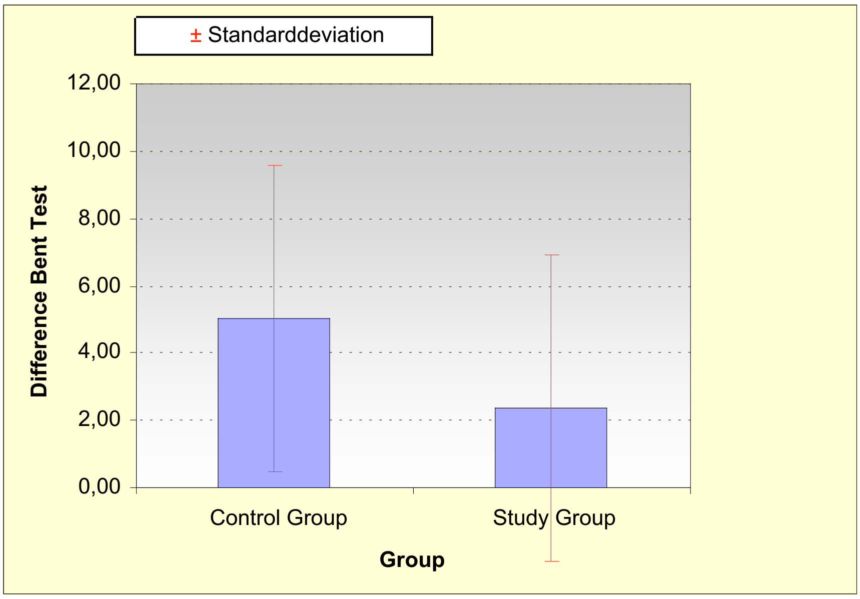


Table 112: Difference Bent Test

The bent test was performed with a finger position which is very often used in climbing, especially on smaller holds. However, the forces which appear are much higher than in the hanging finger position (see chapter 4).

Here the mean for control group was higher (5.03 kg) than in the study group (2.38). But with the confidence at 95% the value was pretty similar with 3.49 (control group) and 2.63 (study group). Also the Standard deviation was similar with 4.54 (control group) and 4.55 (study group).

Again, the t-test showed no significant results (t-value: 1.364)

7 Discussion

Although the study was conducted over more than two years ago, only 14 climbers could be found for the study group and 9 for the control group. Already, Klauser et al. (1999, 736) found that there may be a large number of unreported cases because some 60% to 70% of injured climbers do not seek medical attention. The subdivision of the patients into three different groups was done using ultrasound by Dr. Klauser (Golden Standard) and the percentage of climbers in each group is similar to other studies. For example Hochholzer found that injuries of the Annular Pulley System, followed by tendovaginitis and finger joint related problems are the most common finger problems sport climbers have to deal with (Hochholzer/Schöffl 2001, 27).

Pfeifer et al. (2000, 965) found that the red-point level is significant regarding with the risk for injuries and over use damages. This study showed that the kind of finger injury is not dependent on the climbing level (6.8.2.1).

The performance level of the climbers in this study was very high. The mean of the red-point maximum level was 7c and 7c+ (control group).
Looking at the red point improvement level between the entrance and the control test of all athletes the mean of the study group was a little bit higher and all climbers of the study group have returned to climb again (6.8.1.4).
If we only take the red point improvement level of the climbers who have been practicing their sport at the time of the entrance and the control test we can even find a significant result for the study group (6.8.2.2)!
This can be called a confirmation of my hypothesis, but again the relatively small number of athletes must be kept in mind.

In contrast to this statistical result stands the result of the ultrasound improvement: Here the group of the annular pulley injuries has significantly better results in the control group (6.8.2.3). But if we compare the red-point improvement level of this lesion group (annular pulley injuries) and take only people who have been climbing at the entrance and control test the group with the osteopathic treatment gets better results (6.8.2.4).

And also in the test “US improvement sorted after treatment”, the group who has been treated from Dr. Klauser with cortisone injections has in this study better ultrasound improvement results than the study group (6.8.2.5).

These statistic statements underline one more time the important roll of the fascial system as a support-, carrier- and protection system (Paoletti 2001, 146).

Every climber knows that it is impossible to keep a performance level constant over a longer period of time. Therefore, many athletes plan their peak performance levels over the year. They normally divide the year into three phases: preparation-, competition- and transition stage (Güllich/Kubin 1986, 184).
This means that if a climber gets injured during his competition or peak level stage, he would reduce his climbing intensity and quantity afterwards anyway. Because of this fact, reduced performance levels for the pulling test could be expected as well.

An ultrasound improvement showed no significant correlation with a climbing reduction but the tendency to reduce the quantity of training seems to be good for the healing process!
Only the group that reduced their training frequency four times per week showed very little improvement. This is probably the result of having climbers with more difficult injuries in this class who need longer time to heal.

As an osteopath and sport climber, I am very pleased to have found a treatment method that the climbers accept and are satisfied with. Even though the injuries are often very painful, climbers want to continue training no matter what, as is mostly the case with elite athletes. This mindset carries over to their philosophy about treatment, where they already want to feel the effects during treatment. Therefore the climbers are willing to accept the sometimes painful fascia techniques. While climbers are reluctant to seek medical help for their problems, for the most part the patients of the study group were pleased with the results.

8 Summary

To my knowledge, this was the first study ever done in the field of “climbing fingers” and osteopathy.
Many sport climbers from all over the world have chosen Innsbruck as their place to live and climb, due to the optimal training conditions.
Even though many of them have to deal with painful fingers, only 23 climbers could be found to participate in this study.
The time between the entrance and the control test was only 6 to 8 weeks. For new studies a re-test after several months would be of great interest.

In several tests it has been proved that osteopathy offers good possibilities to help sport-climbers with typical finger injuries.
This thesis could be a good guide-line for physicians who are treating injured climbers.
In my practice, I also see rock-climbers without any finger injury, but work preventatively with them. This topic would also be very interesting for new studies.

To get more well-founded answers, a study with a much larger group has to be done.
With the help of this thesis, osteopathy has become more popular in the climbing scene.

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10 List of Figures and Tables

11 Appendix

French Grading System	Decimal Numbers
6a	6,00
6a+	6,17
6b	6,33
6b+	6,50
6c	6,67
6c+	6,83
7a	7,00
7a+	7,17
7b	7,33
7b+	7,50
7c	7,67
7c+	7,83
8a	8,00
8a+	8,17
8b	8,33
8b+	8,50
8c	8,67
8c+	8,83
9a	9,00

Table 12: Climbing grading system converted into a decimal system

Study Group

Name	Date of Birth	Climbing Years	Max. Red-point	US-Diagnosis	Finger			Climbing/ Week	Current max. Red-point level	Current Climbing/ Week	Hanging Test	Bent Test
									Entrance Check			
Weber Georg	15.06.1984	5	8b	C	left	4		4		0	18,0	12,6
Roth Cody	28.10.1983	8	8c	A	left	3	PIP	4	8a	3	19,0	13,4
Kuess Mario	05.12.1984	4	8b	B	right	4	A2	4	7c	2	14,0	8,2
Eller Helene	06.06.1967	8	6c	B	right	3	A2	3	6a	2	8,2	10,0
Angerer Christine	06.10.1962	3	6a+	A	right	1	PIP	2	6a	1	7,2	11,0
Milewsky Hans	12.01.1978	14	8b+	A	right	3	PIP	4	8a	2	14,0	8,0
Schöpf Christoph	06.02.1981	5	6c	B	left	4	A4	3		0	5,8	10,2
Kamleitner Bernh	07.03.1981	3	7c	B	left	4	A4	4		0	12,0	2,8
Pichler Wolfgang	18.04.1970	16	8a	B	left	4	A4	3	6b	1	18,0	4,8
Bernardo Gimenez	31.12.1967	8	8a	B	right	3	A2	3		0	19,8	3,2
Peis Daniel	18.01.1986	6	7c+	C	left	4		3	7b	2	2,6	4,0
Allgäuer Erich	10.04.1976	7	7c+	C	left	4		3	7a	1	11,4	14,4
Vergeiner Katja	13.10.1977	10	7b	B	left	4	A4	2	7a	1	4,8	4,6
Lama Ringi	11.06.1965	10	6c	A	left	3	DIP	2	6b+	1	12,6	11,4
Mean	**30 years**	**7,6**	**7c**					**3,1**	**7a**	**1,1**	**12,0**	**8,5**

Name	Control Check								Differences	
	US Improvement			Type of Treatment	Current max. Red-point level	Current Climbing/ Week	Hanging Test	Bent Test	Hanging Test	Bent Test
Weber Georg	1	?	0	Osteopathie	7a	1	20,0	15,0	2,0	2,4
Roth Cody	2	?	0	Osteopathie	8a+	3	20,0	20,0	1,0	6,6
Kuess Mario	2	?	1	Osteopathie	8a+	2	18,8	8,8	4,8	0,6
Eller Helene	1	?	1	Osteopathie	6b	2	10,0	5,8	1,8	-4,2
Angerer Christine	2	?	0	Osteopathie	6a	1	11,8	6,4	4,6	-4,6
Milewsky Hans	2	?	0	Osteopathie	8a+	2	16,0	17,0	2,0	9,0
Schöpf Christoph	2	?	1	Osteopathie	6b	1	13,8	10,2	8,0	0,0
Kamleitner Bernh	2	?	2	Osteopathie	7a	2	18,2	11,4	6,2	8,6
Pichler Wolfgang	2	?	1	Osteopathie	7a	2	18,0	13,0	0,0	8,2
Bernardo Gimenez	2	?	1	Osteopathie	7b	1	15,6	4,2	-4,2	1,0
Peis Dan iel	1	?	1	Osteopathie	7b+	3	4,2	6,1	1,6	2,1
Allgäuer Erich	2	?	1	Osteopathie	7b	2	14,4	15,0	3,0	0,6
Vergeiner Katja	2	?	1	Osteopathie	7a	2	8,2	2,4	3,4	-2,2
Lama Ringi	2	?	2	Osteopathie	6b+	1	12,4	16,6	-0,2	5,2
Mean					**7a+**	**1,8**	**14,4**	**10,9**	**2,4**	**2,4**

Control Group

Name	Date of Birth	Climbing Years	Max. Red - point	US-Diagnosis	Finger	Climbing/ Week	Current max. Red - point level	Current Climbing/ Week	Hanging Test	Bent Test
						Entrance Check				
Lener Angelika	10.07.1967	3	6a+	C	left 4	3		0	2,8	5,0
Plötzeneder Nando	18.10.1974	5	6b	B	right 4 A2	1		0	10,0	3,6
Grünewald Stephan	05.08.1982	9	7b	B	right 4 A2	2	6b	0	16,2	4,0
Allgäuer Erich	10.04.1976	10	8a	B	right 4 A2	3		0	15,0	5,6
Wurnig Peter	14.11.1967	23	7c	B	right 3 A2	2	6b	1	9,2	3,0
Ludescher Andreas	04.02.1968	20	8c	B	right 4 A2	4	7a	3	8,6	5,5
Langes Christoph	02.12.1970	20	8b+	A	right 3 PIP	3	8b	3	20,0	5,2
Fischhuber Kilian	01.08.1983	10	9a	C	right 3	4	7c+	3	6,0	3,4
Scherer Reinhold	18.12.1965	25	8c+	B	right 3 A2	3	8a	1	20,0	5,4
Mean	**33,0 years**	**13,9**	**7c+**			**2,8**	**7b**	**1,2**	**12,0**	**4,5**

Name	Control Check						Differences	
	US Improvement	Type of Treatment	Current max. Red-point level	Current Climbing/ Week	Hanging Test	Bent Test	Hanging Test	Bent Test
Lener Angelika	2 ? 0	1	6a+	3,5	4,0	6,2	1,2	1,2
Plötzeneder Nando	2 ? 1	1			7,2	3,0	-2,8	-0,6
Grünewald Stephan	2 ? 1	1,3	7a	2,0	19,8	8,8	3,6	4,8
Allgäuer Erich	2 ? 0	1,3	7b	4,0	16,0	10,4	1,0	4,8
Wurnig Peter	2 ? 1	1	6a	1,0	13,4	4,6	4,2	1,6
Ludescher Andreas	2 ? 0	3	7a	2,5	10,0	9,2	1,4	3,7
Langes Christoph	1 ? 0	1,3	8b+	3,0	20,0	15,8	0,0	10,6
Fischhuber Kilian	2 ? 1	1	8c	4,0	11,2	9,0	5,2	5,6
Scherer Reinhold	2 ? 1	1	7c	1,0	20,0	19,0	0,0	13,6
Mean			**7b**	**2,6**	**13,5**	**9,6**	**1,5**	**5,0**

Questionnaire for Entrance Test:

Hello Climber! Date:

My name is Michael Otepka. For my Osteopathie Master Thesis I need your help.

Since 20 years I'm a rock-climber and I'm very interested in the frequent finger injuries in this sport.
If you are suffering since at least 6 weeks from a typical painful "climbing finger", please answer the following questions and I wish you…………

A GOOD RECOVERY and in the future a lot of fun climbing

General hints with injuries and over-use problems:

- Reduce training intensity and frequency
- Maybe take a break from training
- Avoid climbing with the bent-finger position
- Thorough Warm-Up before training, maybe using tape for the injured area
- Pain is a good signal with how much load I can already bear the finger and should be avoided!

Name:

Date of birth:

Climbing since:

Maximum red-point level:

Normal climbing frequency/week:

Date of injury:

Maximum red-point level at the moment:

Climbing frequency/week at the moment:

Thank you!!

Questionnaire for Control Test:

Dear climber!

Thank you that you show up for the Control Test.

Date:

Name:

What kind of therapy have you done?

Maximum red-point level at the moment:

Climbing frequency/week at the moment:

Thank you very much for your help!
Good luck and a lot of fun climbing
Michael Otepka

12 Glossary: Technical Terms

- Red-point: the belay chain (rope, bolts, and karabiners) is used only for security and is never loaded during the climb. The climber is leading a climbing route. This means he is moving up from the ground to the top of the climb and has to clip the rope into the karabiners and bolts.
- Bent Finger Position: is mostly used for very small holds. The flexion in the PIP joint is < 60° and the PIP joint is over-extended. The wrist is slightly over-extended. The impact for tendons and ligaments is very high.
- Hanging Finger Position: is mostly used for bigger holds. The PIP, DIP and MCP joint are flexed. The finger joints are in a middle position therefore the impacts can get better absorbed by the tissues.
- Sloper or negative Grip: The inclination of the grip-area to the vertical and its orientation towards the rock surface allow a differentiation of holds. In this case the grip-area is turned away from the rock wall.
- Positive Grip: The grip area is turned towards the rock wall.
- Dynamic Climbing: In opposition to static climbing the distance between to holds might be so long that only a dynamic move can help to reach the next grip. In this case the impacts on the finger are much higher than in a static climbing style.
- Bow-Stringing: In a flexed finger position an increased distance between the flexor tendon and the phalanx is found; typical sign for annular-pulley ruptures.

Eidesstattliche Erklärung:

Ich erkläre hiermit, dass ich die vorliegende Masterthese selbstständig angefertigt habe. Die aus fremden Quellen direkt oder indirekt übernommenen Gedanken sind als solche kenntlich gemacht.

Die vorliegende Masterthese wurde noch nicht anderweitig für Prüfungszwecke vorgelegt und auch noch nicht veröffentlicht.

Innsbruck, am 12.Dezember 2006