The European Proceedings of
Social & Behavioural Sciences
EpSBS

Future Academy ISSN: 2357-1330

https://dx.doi.org/10.15405/epsbs.2019.02.56

ICPESK 2018
International Congress of Physical Education, Sports and Kinetotherapy. Education and Sports Science in the 21st Century, Edition dedicated to the 95th anniversary of UNEFS

SOMATIC AND FUNCTIONAL DEMANDS SUSCEPTIBLE TO CAUSE HAND INJURIES IN SPORT CLIMBING

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Abstract

Identification of the somatic and functional demands of the hand in sport climbing allows us to propose alternative exercises aimed to prevent injuries, as well as physiotherapeutic solutions to be used in the treatment of undesirable manifestations that may occur following the intensive practice of climbing. The study of the literature reveals that the most common hand injuries are: the flexor tendon tunnel (A2 pulley) injury, which is the most frequently encountered in sport climbing and occurs during specific grips; tenosynovitis, which may occur if the breaks between demands are not sufficiently long; deep digital flexor tendon and superficial digital flexor tendon injuries, lumbrical muscle injuries; proximal interphalangeal synovitis, which also has a high incidence, is caused by overexertion. The purpose of our research is to determine the type of somatic and functional demands encountered in climbing and to make a map of the hand structures subjected to specific tensions in the case of subjects practicing this sport. At the same time, we aim to provide a kinetoprophylactic programme for these structures, as well as a kinetotherapy programme for possible injuries. In our approach, we shall use the casuistry presented in the literature, but also the one identified in the subjects participating in this study.

Keywords: Sport climbing, kinetoprophylaxis, kinetotherapy, hand. .

https://dx.doi.org/10.15405/epsbs.2019.02.56
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Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

1. Introduction

Sport climbing is among the five sports disciplines recently included in the programme of Tokyo 2020 Summer Olympics and Buenos Aires 2018 Youth Olympic Games. The decision was certainly influenced by the growing number of climbers from all over the world.

For a long time, a niche discipline within the outdoor activities, sport climbing has a constant development everywhere on the globe, in all age groups and both genders.

In Romania, climbing is rather regarded as a leisure sports activity, which is most often performed in specially equipped rooms. However, we have noticed lately an increase in the number of people who also choose to practice it in the natural mountain setting, using the purposely designed routes. As the number of climbers grows, there is also an increase in the number of routes set for a wide scale of difficulty, according to the type of rock specific to different zones in the Carpathian Mountains.

The large number of people practicing sport climbing has increased the rate of injuries to the lower extremity, more specifically the foot/ankle, as well as the head, spine and hand.

Generally, the incidence of hand injuries can be correlated with the duration and frequency of practicing sport climbing and the different techniques used. Most hand injuries in climbers are relatively minor and can be treated by rest, anti-inflammatory medication, orthotics, and taping tapes. Certain lesions require surgery, and if neglected or not correctly diagnosed, they may have serious functional consequences on the hand. These serious hand injuries include flexor tendon strains, pulley strains and ruptures.

Although these injuries may seem sometimes minor and irrelevant, they can seriously compromise the possibilities and safety when practicing sport climbing. In this regard, we think that correct diagnosis, treatment, rehabilitation and prophylaxis are essential in addressing sport climbing injuries.

2. Problem Statement

Since sport climbing is practiced to a greater extent as a leisure activity rather than a performance sports activity, it is understandable that the training of those concerned is mostly focused on the formation of minimal specific skills able to give participants immediate satisfaction when covering low-difficulty routes, thus providing moments of relaxation and joy within the group of friends. As they become more interested in climbing, the challenge is to diversify training, even if there is still no question of achieving performance in competitions.

Approaching routes of moderate and above-moderate difficulty, namely the grades 6-7 (as mentioned by the International Climbing and Mountaineering Federation), involves important somatic and functional demands. The techniques are more and more diversified, and the climber's body adopts positions and initiates increasingly complex movements. The limbs are preponderantly stressed, but concomitantly the body seeks the most efficient positions to maintain balance and advance on the route. Supporting the feet on sometimes imperceptible surfaces and grasping contact areas of various sizes and shapes represent the climber's actions that maintain contact and ensure advancement on the route. The way of equipping the route and securing the rope with quickdraws often involves maintaining the body weight in three or even two support points, namely vertically, overhanging or to the ceiling of the climbing wall.

In these situations which, for the high-performance sport climber, become so difficult that they are hard to imagine by the novice viewer, the demands on the muscles and especially the joints are very

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aggressive. Over time, the repetitive pressure, torsion and traction exerted on the joints may cause major long-term discomfort and sometimes serious injuries.

For this reason, we think that climbers should focus on two significant issues: the training of suppleness and mobility, as well as the prevention of joint injuries.

In this paper, we aim to identify the type of demands on the climber's hand during the actions of gripping various contacts.

Therefore, we consider it necessary to make a short description of the types of holds (handholds) that can be found in the artificial or natural climbing wall, and also of the grips that the sport climber includes in the specific technique.

Types of grips (according to Woodward, 2016)

The crimp grip: when crimping, the second knuckle arches above the fingertips and thus a downward force is acting on the hold. In order to increase strength in the crimp, the thumb must wrap over the index finger, which results in a ring grip. The action of the thumb leads to an increase in the number of hand muscles that start working actively for maintaining contact. The crimp, a solid and powerful hand position, is commonly used for thin edges. Nevertheless, care must be taken with this grip that puts a lot of stress on both the tendons and finger joints.

The pinch grip: when pinching, the thumb is in opposition to the fingers, although the opposing faces may not always be edges with positive rims. This grip is used on sloppy knobs or two side-by-side pockets.

The open grip: uses the contact strength of the hand to keep positive friction on a hold. It is used on slopes, but its application is not restricted to a specific type of hold. To achieve effective friction, the maximum surface area of the hand should be in contact with the hold. Since the hand has the property to curve in a natural way, with reduced joint angles, and its position allows the rock to provide support to tendons, an open grip places the least amount of stress on the joints and tendons.

The friction grip: occurs when the open grip is used to smear the hand on the wall.

The wrist wrap (monkey hook): is used when the climber has to hold on to large slopers/jugs. The heel of the hand is simply hooked over the hold. During this grip, body weight is transferred from fingers to wrists, thus allowing the hand muscles, joints and tendons a break.

According to Parks (2017), two techniques help the climber take full advantage of any hold:

Squeezing only as hard as needed to maintain a hold. However, this exhausts forearms prematurely, and therefore the climber will feel "pumped" because of the heavy blood flow which goes to arms when they are tensed.

Focusing on the direction the climber wants to pull. In order to achieve the easiest and strongest grip, the pull must be perpendicular to the hold. If the weight is lined up with the direction of pull, it will be less likely for the climber to come off the rock.

The types of holds and handholds that can be used are the following (Woodward, 2016; Parks, 2017):

Edges/Ledges: are known as the most usual holds. The edge is a flat face meeting the wall at about a 90^0 angle. They can be as follows: tiny dime edges (hardly wide enough for the toe of the shoe), long cuts in the wall (allowing room for both hands) or huge ledges (large enough to lift the entire body onto at the top of a climb). Edges are possible to face any direction on the wall, so climbers have to make sure they grip the direction of pull. This type of hold can be slightly rounded and also have a positive outside rim.

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Crimper: a small shallow edge where there is only enough room to place one knuckle or one finger pad on it positively. There are two ways to hold a crimp:

Closed or full crimp: when the knuckle angles are sharp and the thumb is tucked over the fingers to get additional power. This is a stressful position for the finger tendons.

Open grip: when the fingertips are on the edge, and the rest of the hand is wrapped onto the wall. This is a grip that places less stress on the finger tendons.

Sidepull: a vertical or diagonal edge whose positive face points away from the climber. Thus, the pull is performed laterally instead of being done straight down.

Pinches: two edges protruding from the surface of the rock or holds with two opposing faces that are pinched to grip. Commonly, pinches are gripped by the whole hand using the thumb in opposition, because this adds much gripping power.

Pockets: holds that have a shallow or deep opening, allowing the climber to hold them with 1 to 4 fingers. A pocket can take any direction of pull. The 1- and 2-finger pockets are the most dangerous, which is why climbers need to be careful to avoid tendon injury.

Slopers: rounded handholds lacking a definite edge or rim to grip. They are more positive when body weight is directly distributed below the hold, while keeping the arms straight. Although slopers are not the easiest holds to grip, they place the least amount of stress on the finger tendons.

Flakes: a thin piece of rock, which is detached from the main face and leaves a crack between it and the bigger rock. To climb a flake, it is often easier to just wrap the hands around it and lay back off the edge. When the incut of a flake is facing down, this is called an undercling. Effective underclings need oppositional force and become more positive as the climber's feet move up.

Jugs: traditionally large open holds with space for both of the hands to fit on the hold. Most climbers prefer them, because they are easy to grip and provide excellent rest.

To climb efficiently and prevent injury, it is crucial to learn how to hold onto different handholds. There are several ways to grip every hold, but some of them are more effective. While climbing, quick discernment of the various grips and their relative strengths represents an important set of skills to develop. (Woodward, 2016)

3. Research Questions

The grip techniques exert pressure, torsion and traction actions on the hand joints.

The study of the literature reveals that the most common hand injuries are: the flexor tendon tunnel (A2 pulley), which is the most frequently encountered injury in sport climbing and occurs during specific grips because of the persistent closed hand crimping; tenosynovitis, which may occur if the breaks between demands are not sufficiently long; deep digital flexor tendon and superficial digital flexor tendon injuries, lumbrical muscle injuries; proximal interphalangeal synovitis, which also has a high incidence, is caused by overstress.

4. Purpose of the Study

The purpose of our research is to determine the type of somatic and functional demands on the hand in sport climbing and to make a map of the hand areas subjected to specific tensions.

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Identification of the somatic and functional demands on the hand in sport climbing will allow us to understand the mechanisms that cause hand injuries and finally to establish rehabilitation directions including alternative exercises aimed to prevent injuries, as well as physiotherapeutic solutions to be used in the treatment of undesirable manifestations that may occur following the intensive practice of climbing.

5. Research Methods

Numerous studies describe a wide variety of injuries that occur during the practice of sport climbing, and the grip techniques are responsible for this in most cases. Thus, one can identify mild injuries, such as flexor tendon strain, tenosynovitis/tendinitis, joint contractures, carpal tunnel syndrome, pulley ruptures and complete ligament tear; but there are also serious injuries, such as locked digits, flexor tendon ruptures/avulsions and severe joint contractures (Jebson & Steyers, 1997).

The most common hand injuries are the following (Lee, 2017):

Flexor tendon pulley injury, commonly A2 pulley. The mechanism that leads to this high-incidence injury is the persistent closed hand crimping, because of the finger joint orientation. Thus, the proximal interphalangeal joint (PIP) is flexed above 90 degrees, while the distal interphalangeal joint (DIP) is hyperextended, and, in these conditions, much greater force acts on the pulley system due to tendon friction. Predominantly the ring finger is prone to this type of injury: the middle finger is supported by relatively long and strong fingers, while the ring finger has only one long and strong finger on one side, so it is relatively weak, which means that it is more prone to lesions.

According to Smith (2017), in establishing the rehabilitation protocol, an important issue refers to the time elapsed since the injury: did it occur in the past 6 weeks or more than 6 weeks ago? In the first 6 weeks after an injury, controlling inflammation and recovering function is very important (Phase 1). After 6 weeks, the active remodelling of the tissue is crucial (Phase 2).

In Phase 1 (the first six weeks), the rehabilitation programme can use various means and methods. Inflammation control is achieved by rest, ice, compress and tape. The evolution of symptoms guides us in this phase, which may last for several weeks. To recover hand function, mobilisations in different forms are beneficial.

Tendon glides: progressive flexion/extension of the fingers for gliding your tendons through their full range of motion. 10 repetitions must be performed, 3-5 times a day.

Pen rolling: hold a pen between your finger pads and the top of your palm, rolling back toward the palm by grasping it with one finger at a time, gradually from the little finger to the index finger. Repeat for 1 to 3 minutes, 3-5 times a day. Gentle massage for 1-3 minutes daily is also recommended.

To recover the range of motion, active mobilisations will be used. In a rice bucket, a variety of finger and wrist motions can be easily performed with the resistance of the rice. A straight line must be kept between your forearm and hand (which is called “a neutral wrist”). 30 seconds for each motion, 1-2 times a day.

Light putty gripping: putty must be pulled apart using different grips. Towel gathering: tendons move by gathering a towel in your hand, while maintaining “a neutral wrist”. 1 to 5 minutes daily. (O’Leary & Leonfellner, 2014)

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2-Finger Pocket Hang: maintain your body suspended with two fingers. Symptoms that occur during the hang must be of low intensity (whether experiencing strain or slight pain). They should disappear within 10 minutes after the hang, without any loss in the range of motion or stiffness caused by the exercise.

2-Finger Pocket Hang + Pulley System: if symptoms exceed 10 minutes or hanging is unbearable, reduce body weight using a pulley system or an elastic band. Perform 3 repetitions of the 10-second hang, with a 2-3-minute break between them. After the load testing, the strain felt during the hangs should disappear within 10 minutes and stiffness or a decrease in the range of motion should not occur. The injured tissue remodelling starts with a gentle warm-up that lasts 10 to 30 minutes and is based on selective exercises used in Phase 1 or gentle climbing, provided that they are pain-free. It is not recommended to perform the loading programme in a state of fatigue. The remodelling step begins with the "Load testing". Perform a 10-second hang 3 to 5 times, separated by 2-3 minutes of rest, 1 to 3 times per week, using the same weight until this no longer causes symptoms (strain or slight pain). When the initial load stops producing symptoms, 2.5-5 kg can be added at a time above body weight, progressing up to 15-30 kg over body weight in the next 6 to 8 weeks. The load can be increased within a session if it does not produce symptoms or can be gradually increased for 6 to 8 weeks.

Generally, the load increases every week to go on remodelling the tissue and reproducing the symptoms (strain or pain) (Smith, 2017).

2-Finger Pocket Hang + Added Weight: when you are able to hang with 15 kg over body weight, you can continue to use other grips, too. If there are problems with the pinch or crimp, similar progression with those grips can be done. Other hang/pinch grips can be mixed in one or two during the same session (2-Finger Pocket Hang, 1/2 Crimp Hang, Pinch Block): warm-up, a 10-second hang, 2-3 minutes of rest, 3 to 5 sets for each grip, 1 to 3 times per week.

Rehabilitation is completed when no residual symptoms are present during training or climbing and/or when achieving a 2-finger pocket hang with 20-30 kg over body weight, with no symptoms.

The prophylactic methods for hand injuries include skin protection, physical exercise and compression bandages. An exercise programme containing stretching exercises, as well as free-active and resistance mobilisations for the hand and finger joints will help prevent tendon and muscle injuries. Exercises to increase muscle strength should also be included by gradually increasing the duration and intensity of exercises against resistance. A series of exercises presented above can be used for prophylactic purposes. Applying tapes wrapped around the finger will help prevent skin and finger injuries.

6. Findings

The map of the demands on the hand includes the following situations:

Hand tensioning when grasping contact areas (jug, pinch, flake) and performing the hand and finger holds specific to crack climbing

Pressure on the first knuckles or the entire hand during pressure grips (crimp, sloper)

Phalanx traction in hanging positions and reverse grips (undercling, flake)

Torsion and traction of the first knuckles or the entire finger during pocket grips

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Crimping is a main cause of the flexor tendon pulley injury, commonly A2 pulley, because of the finger joint orientation. Thus, the proximal interphalangeal joint (PIP) is flexed above 90 degrees, while the distal interphalangeal joint (DIP) is hyperextended, and, in these conditions, much greater force acts on the pulley system due to tendon friction.

For all grips, the hand and finger joints usually perform within ranges of motion that are in non-functional sectors. At the same time, the grips may involve different stresses on the muscles for a long time, depending on the situations encountered while climbing.

The protocol for the rehabilitation and prophylaxis of hand injuries is carried out step by step, being purposely designed for those who practice sport climbing. In order to achieve the goal, the rehabilitation plan is designed in several phases aimed at reducing pain, inflammation and overexertion of the involved structures to gain maximum range of motion, muscle strength and endurance, as well as practicing sport climbing without discomfort.

7. Conclusion

The considerable increase in the number of people practicing sport climbing has implicitly led to an increase in the rate of injuries to the lower extremity, more specifically the foot/ankle, as well as the head, spine and hand. Generally, the incidence of hand injuries can be correlated with the duration and frequency of practicing sport climbing and the different techniques used.

Because the hand is overstrained in the full or closed crimp, the pulley injuries have a high incidence. During the training or climbing/campussing, the use of an inappropriate technique will overexert the pulleys, and this will finally result in injury. A few training sessions mainly aimed at correcting the technique, preferably by video analysis, can prevent the emergence of such problems.

Rehabilitation will generally be conservative and will mainly focus on pain, joint mobility, muscle strength and endurance. The rehabilitation process will progress as the pain decreases and the hand function improves.

Within the rehabilitation process, the exercise has a prophylactic, therapeutic role and will allow the user to constantly self-monitor and self-assess with regard to the healing of hand injuries caused by traumas encountered in sport climbing.

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