

Scientific Paper

**A STUDY ON THE PREVALENCE OF MUSCULAR-SKELETON  
INJURIES OF ROCK CLIMBERS**

*UDC 796.525 : 616.001*

**Ahanjan Shahram, Abdulmalek Farzad, Rajabi Reza**

Department of Physical Education and Sport Science, Razi University, Kermanshah, Iran  
E-mail: ahanjan@mail.ru

**Abstract.** *The purpose of this study was to consider to prevalence of muscular - skeleton injuries in rock climbing, and to determine some individual performance factors such as the maximum grade of climbing, skillful hand and common type of climbing on the existence and circumstances of the injuries. In the period from February to April 2005, the previous or present injuries of 50 climbers were assessed via a clinical examination of their fingers, palms, wrists, forearms, elbows, arms and shoulder girdles. After the data gathering, statistical analyses were carried out to obtain results about the prevalence of muscular - skeleton injuries. About half of the injuries were to the fingers and the rest were approximately divided equally between the elbows-forearms and shoulder girdles. Most injury prevalence consisted of collateral ligament strain of the PIP joints, FDS and FDP muscle strain, rotator cuff muscle strain and A2 annular pulley strain. The injury prevalence rate on the basis of its appearance in the fingers is regularly found in the ring, middle, index and small finger. In subsequent processes, inferential statistics results show that among the mentioned factors, there was a significant difference in the mean of the climbing maximum grade between the groups of climbers that sustained injuries and groups of climbers without injuries ( $p=0.000$ ,  $t=4.72$ ). In the same way, there was a significant positive correlation between the maximum grade of climbing and the intensity of the A2 annular pulley injuries ( $p=0.042$ ,  $r=72.5$ ).*

**Key words:** *muscular-skeleton injuries, rock climbers, annular pulley system, maximum grade of climbing, skillful hand, type of climbing*

1. INTRODUCTION

Rock climbing movement requires following a pattern that mostly exerts abundant pressure on the muscular – skeletal system of the upper limbs. Total body weight is placed on the hand and one finger or more, many times during the performance. There-

fore, active limbs, such as the hand and finger in particular, acting as support and connection points between a climber's body and the wall, are susceptible to movement injuries. Because of the load, injuries such as annular pulley system damage, finger flexor muscle injuries, different damage to the PIP joint and its collateral ligament, external and medial epicondylitis, biceps brachii strain, shoulder girdle injuries, especially to the rotator cuff muscles and even neuropathy in the hand medial nerve are common cases. Naturally, the probability of an injury occurring rises in periods of decreased fitness, either physically, technically or psychologically speaking (Bollen, 1988, 1990; Holtzhausen and Noakes, 1996; Logan et al., 2004; Shea et al., 1992). On the other hand, the rocky mountains, such as the Zagros peaks, create a basis for natural sports activities such as rock climbing in the western provinces of Iran. In conjunction with an increased tendency to use this course, the chances of injury are inevitable. In fact, the appearance of injury is an inseparable part of severe exercise. Studies in the field of injury prevalence have led to additional knowledge of injury patterns, and their results can reflect the quality of exercise sessions. So, if a coach and athletes are familiar with the results, they can prevent probable injuries by applying prophylaxis methods, such as a certain kind of training of the parts that are more exposed to risk.

Largiader, & Oelz (1993) have obtained a result by means of an analysis of overstrain injuries in rock climbing. Between the spring and autumn of 1990, a study was performed with the goal of recording and classifying overstrain injuries due to rock-climbing and of defining their causes. Of the 332 climbers who participated in the study, 114 (34.4%) had suffered at least one overstrain injury. The degree of one's climbing skills proved to be the main risk factor; with an increase in the climbing skills of the observed persons, the percentage of injuries increased substantially. The degree of one's climbing skills also was the only significant difference between the injured and non-injured persons—the injured persons had a climbing skill which was 1.3 degrees (UIAA) higher. Warming up did not prevent most overstrain injuries. A total of 237 injuries were described. 34.6% of these were long-term defects such as foot deformations and nail dystrophies in the toes. 65.4% were overstrain injuries; 90.3% of these cases had to do with the upper part of the body and the upper extremities, including the thoracic girdle, areas which are particularly strained in climbs of high degrees of difficulty. The areas affected were almost exclusively tendons, joint capsules and ligaments. By far the most frequent injury of the upper extremities was the proximal interphalangeal joint injury, followed by injuries to the proximal phalanx, the flexor tendons of the forearm and the distal interphalangeal joint. With regard to training injuries, finger injuries occurred most frequently in addition to elbow injuries. 51% of the overstrain injuries were severe, with a healing time from several months to several years. Only 30% of the injured persons consulted a physician (Largiader & Oelz, 1993).

From May to September 1994, a study by Schafer, Gaulrapp, and Pforringer was carried out in the field of acute and chronic overuse injuries in rock climbing. The etiology of trauma was concerned with training forms and climbing techniques. 112 climbers who participated in the study climbed at the 9+/10- level (8a). This study demonstrated that the incidence of overstrain syndromes increased with the performance level. The overall predominance of finger injuries was followed by acute spinal syndromes, knee, and ankle sprains. Among the most frequent overstrain complaints, epicondylopathias, chronic complaints of the finger joints and flexor tendons, and nerve compression syndromes of the upper extremities could be seen. Most notable was the fact that the frequency of cer-

tain overstrain syndromes increased in relation to the years spent climbing (Schafer et al., 1998).

Rooks, Johnston, Ensor, McIntosh, and James (1995) studied 39 recreational rock climbers to determine the incidence and pattern of sport injuries sustained at their level. Eleven climbers (26%), whose climbing went beyond the sport level, had sustained a major injury from a fall. Thirty-five climbers (89%) sustained at least one significant injury. Fifty percent of the injuries involved the hand or wrist. Only seven climbers (19%) showed evidence of a digital pulley injury (climber's finger). Four climbers (11%) showed evidence of carpal tunnel syndrome. Twenty climbers (50%) had tendinitis in an upper extremity, which was detected during a physical examination (Rook et al., 1995).

Pfeifer, Messner, Scherer, & Hochholzer (2000) investigated injuries and overstrain syndromes of 99 adolescent climbers aged between 8 and 19. The authors interviewed climbers from Austria, Germany and Switzerland. Besides the type and pattern of injuries and overstrain syndromes, the level and duration of climbing, the intensity of training and gender were all recorded as potential risk factors. 47 climbers were asked about setting up fingers on small holds, which is considered to be the main reason for epiphyseal injuries of the fingers in the relevant literature. Injuries and overstrain syndromes, as well as their frequency and pattern, were reported and classified. Descriptive data analysis and statistical models were used to assess the influence of risk factors. Among the potential risk factors, only the level of climbing has a significant influence on the risk of injury and overstrain syndromes ( $p = 0.0427$ ). Furthermore, the risk of injury and overstrain syndromes in the area of the fingers is significantly higher for climbers who reported setting up fingers on small holds ( $OR = 8.24$ ,  $p = 0.0022$ ). Finally, a higher frequency of injury and overstrain syndromes was found in the lower extremities (43% of all of the injury and overstrain occurrences) and a lower frequency of injury and overstrain syndromes in general (43% of all the climbers under investigation), compared to the results other studies (Pfeifer et al., 2000).

Carmeli & Wertheim (2001) carried out a study whose purpose was to understand the activity, recreational profile and the rate of hand/finger injuries among non-professional climbers. 23 young climbers (mean age 16) and 20 older climbers (mean age 29) participated in a questionnaire study. The data included sociodemographic variables, the level of daily and recreational activities and the climbing profile (experience, training frequency, past injuries, functional and medical diagnoses). The results indicate that young climbers do not sustain hand/finger injuries as frequently as older adults. Men sustain injuries and complain of pain more often than women. Conclusions: overuse, lack of sufficient rest and a more challenging environment appear to be the main factors which contribute to hand/finger injuries among older climbers (Carmeli and Wertheim, 2001).

## 2. METHODS

The method used in this research was a correlation descriptive. The purpose was the examination of rock climber injury frequency and the examination of the correlation between some individual factors which are connected with the occurrence and appearance of injuries.

### **Subjects**

The sample of subjects in this research consists of male climbers from the western provinces of Iran. Therefore, 50 climbers from the cities Ardabil, Hamadan, Kermanshah, Nahavand and Oroumieh have been selected on the basis of cluster sampling.

### **Statistical methods**

Descriptive statistics was used to determine the central and distribution factors.

The Kolmogrov – Smirnov test was used to determine the circumstance of the distribution.

Pearson's correlation coefficient was used to determine the correlation between the variables (in the normal distribution of the data).

Spearman's rank order correlation was used to determine the correlation between the variables (in the abnormal distribution of the data).

The independent t – test was used to determine the mean difference among the factors between the two groups.

A one – way analysis of variance was used to determine the mean difference among climbing maximum grade and injury intensity in 3 climbing types (bouldering, lead, top rope).

### **Data gathering**

The first stage was to study previous research and injury case reports in order to gather a complete list of rock climbing injuries, the pathophysiology and the clinical signs. So, during the next phase, all of the probable injuries were compiled in the form of clinical examinations, and other features such as intensity, duration and the direction of the appearance in the upper limb. On the other hand, according to the hypothesis, some individual – performance characteristics such as the maximum grade of climbing, the skillful hand and common type of climbing, were set in an individual form. The investigative process took place between February and April, 2005. Firstly, everybody wrote their characteristics down in an individual form, and then the researcher, after conducting a clinical examination, filled out a related form. Injury assessment was based on clinical signs such as topical pain, weakness and tenderness (especially with palpation), decrease in range of motion, topical deformity and physical tests.

## **3. RESULTS AND DISCUSSION**

After the data gathering, a descriptive analysis was carried out to obtain results on the muscular - skeleton injury prevalence in rock climbing (Table 1).

According to the results, 70% of the climbers experienced at least one injury, but only 8.75% of them consulted a physician. About half of the injuries were in the fingers (52.08%) and the rest were divided equally between the elbow-forearm (26.03%) and shoulder girdle (21.89%). The injury prevalence rate on the basis of the appearance in the fingers consists of the ring (43.07%), long (41.53%), index (12.3%) and small finger (3.07%) respectively. So, the circumstance for injuries in the fingers can be found in diagram 1. On the other hand, an analysis of Pearson's correlation coefficient (for the

normal distribution of data), Spearman's rank order correlation (for the abnormal distribution of data), the Independent t – test and the one – way analysis of variance provided these results about the effect of some individual performance factors on the existence and circumstances of the injuries.

Table 1. Injury frequency

Injury type	N (climbers with the injury)	%	F (frequency of the injury)	Prevalence percent
DIP joint dislocation	1	1.28	1	1.04
PIP joint dislocation	1	1.28	1	1.04
Collateral ligament strain of PIP	13	16.66	22	23
FDP muscle strain	13	16.66	15	15.62
FDS muscle strain	15	19.23	18	18.75
A2 annular pulley strain	7	8.97	9	9.37
A2 annular pulley tear	1	1.28	1	1.04
Carpal tunnel syndrome	1	1.28	1	1.04
Lateral epicondylitis	5	6.41	5	5.2
medial epicondylitis	2	2.56	2	2.08
Biceps brachi strain	6	7.69	6	6.25
Rotator Cuff strain	11	14.1	13	13.54
Rhomboid muscle strain	2	2.56	2	2.08

There was no significant correlation between the intensity of collateral ligament strain of the PIP, FDP muscle strain, FDS muscle strain and rotator cuff strain with maximum grade of climbing (based on the Yosemite decimal scale), but a significant positive correlation was observed between the intensity of A2 annular pulley injuries and the mentioned factor ( $p=0.042$ ,  $r=72.5$ ).

There was no significant correlation between the frequency of the climber's injuries and the maximum grade of climbing (YDS).

There were no significant correlations between the direction of the appearance of the 5 mentioned injuries in the upper limbs (in the left or right hand) and the climbers' skillful hand.

There was no significant difference in the mean of injury frequency between left-handed climbers and right-handed climbers.

There was significant difference in the mean of climbing maximum grade (YDS) between the group of climbers that sustained injuries and group of climbers without injuries ( $p=0.000$ ,  $t= 4.72$ ).

There was no significant difference in the mean of intensity of the 5 mentioned injuries in various climbing types (bouldering, lead and top rope).

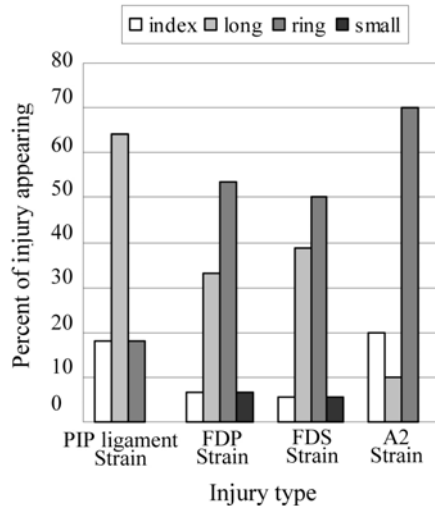


Diagram 1. Injury circumstances in the fingers

There was no significant difference in the mean of injury frequency and climbing maximum grade (YDS) in various climbing types (bouldering, lead and top rope).

Paying attention to the injury type, we can conclude that most muscular – skeleton injuries in rock climbing appear as the result of over – training. In other words, most of the circumstances surrounding injuries indicate that active pressure on a climber's limbs is not proportional with the exerted time, and in terms of fitness levels, the movement of the limbs (especially the fingers and shoulder girdles) will be expose to different grades of injury thresholds. Injury distribution in the fingers, elbow – forearms, shoulder girdles in all of the subjects of the sample used in the research, is in approximate coordination with the explanation offered by Michael & Rooks in 1997. According to the mentioned results, collateral ligament strain of the PIP was the prevalent injury in rock climbing, but this finding differs from the statement issued by Bollen (1990), which reported the A2 annular pulley injury as the most prevalent injury in rock climbing. In the same way, most of the cases regarding collateral ligament strain were reported in the middle finger, which is similar to Bollen's findings (1998). About half of the FDP and FDS muscle strains were reported in the ring finger tendon and more than a third of the cases were reported in the middle finger. Most of the reported cases of A2 annular pulley injuries were reported in the ring finger (70%), a recent result which confirms the research of Moutet et al. So, we can present the following statement on the subject of inferential statistics results:

Depending on the increase of the climbing grade, injury probability will also go up, but the intensity of most injuries, except the A2 annular pulley injuries, is not exclusively dependent on this factor. Therefore, one should keep up the various forms of physical fitness (such as flexibility, muscular strength and endurance, and etc.), psychological and technical factors and avoid over – training, which is essential for injury prevention.

Skillful hand is not the determinating factor for the injuries which appear in one or the other hand. So, irrespective of this factor, injury probability in both hands is equal. Hence, keeping up fitness in both hands is important.

The type of climbing has no effect on the appearance of injury and the severity of the circumstances. In other words, we cannot indicate certain climbing types as the factor for the appearance of injuries and or on the intensity. In fact, because of similar movement patterns in different types of climbing, there is equal injury probability and the probable occurrence of intensity in every type. Therefore, applying prophylaxis methods is essential in every climbing type.

#### REFERENCES

1. Bollen, S.R., & Gunson, C.K. (1990). Hand Injuries in competition climbers. *Br J Sport Med.*, 24, 16–18.
2. Bollen, S.R., (1988). Soft tissue injury in extreme rock climbers. *Br J Sports Med.*, 22, 145–7.
3. Carmeli, E., & Wertheim, M. (2001). Hand injuries in young and old wall climbers. *Deutsche Zeitschrift fur Sportmedizin*, 52 (10), 285.
4. Holtzhausen, L.M., & Noakes, T.D.(1996). Elbow, forearm, wrist, and hand injuries among sport rock climbers. *Clin J Sport Med.*, 6,196–203.
5. Largiader, U, & Oelz, O.(1993). An analysis of overstrain injuries in rock climbing. *Schweiz Z Sport-med.*, 41(3), 107-14.
6. Logan, A. J, Makwana ,N., Mason, G., & Dias, J. (2004).Acute hand and wrist injuries in experienced rock climbers. *Br J Sports Med.*, 38, 545-548.
7. Pfeifer, C., Messner, K., Scherer, R., & Hochholzer, T. (2000). Injury pattern and overuse stress syndrome in young sport climbers. *Wien Klin Wochenschr*, 112(22), 965-72.

8. Rook, M.D., Johnston, R.B., Ensor, C.D., McIntosh, James, S. (1995). Injury patterns in recreational rock climbers. *American Journal of Sports Medicine*, 23 (6), 683 – 685.
9. Rooks, M.D., Johnston, R.B., & Ensor, C.D., et al. (1995). Injury patterns in recreational rock climbers. *Am J Sport Med.*, 23, 683–5.
10. Schafer, J., Gaulrapp, H., Pforringer, W. (1998). Acute and chronic overuse injuries in extreme sport-climbing. *Sportverletz Sportschaden*, 12(1), 21- 5.
11. Shea, K.G., Shea, O.F., & Meals, R.A.(1992). Manual demands and consequences of rock climbing. *J Hand Surg Am.*, 17, 200–5.

## STUDIJA O RASPROSTRANJENOSTI MIŠIĆNO-KOŠTANIH POVREDA KOD PENJAČA PO STENAMA

**Ahanjan Shahram, Abdulmalek Farzad, Rajabi Reza**

*Svrha ove studije je da se uzme u obzir rasprostranjenost mišićno-koštanih povreda kod penjača po stenama, i određivanje nekih individualnih faktora izvođenja, kao što su: maksimalni stupanj penjanja, spretnost ruke i uobičajeni tip penjanja na postojanje i okolnosti povreda. Od februara do aprila 2005. godine prethodne ili trenutne povrede kod 50 penjača su kliničkim pregledima utvrđene na prstima, dlanovima, zglobovima, podlakticama, laktovima, rukama i ramenom pojasu. Nakon prikupljanja podataka i statističke analize o rasprostranjenosti mišićno-koštanih povreda utvrđeni su sledeći rezultati: oko polovine povreda se vezuju za prste, druga polovima približno je jednako podeljena između laktova-podlaktica i ramenog pojasa. Najveća rasprostranjenost povreda vezuje se za posredno istezanje PIP ligamentnih veza, FDS i FDP mišićnih istezanja, istezanja rotatora Cuff mišića i istezanje A2 prstenastog koturača. Rasprostranjenost povreda koje se pojavljuju kod prstiju najčešće se vezuje za domali prst, srednji prst, kažiprst i mali prst. Statistički rezultati pokazuju da, pored spomenutih faktora je postojala i značajna razlika u srednjoj vrednosti maksimalnih stupnjeva penjanja između grupe penjača koja je imala povrede i one koja nije imala povrede ( $p=0,000$ ,  $t=4,72$ ). Na isti način uočena je značajna pozitivna korelacija između maksimalnog stupnja penjanja i intenziteta povreda prstenastog koturača A2 ( $p=0,042$ ,  $r=72,5$ ).*

**Ključne reči:** mišićno-koštane povrede, penjači po stenama, prstenasti sistem koturača, maksimalni stupanj penjanja, spretna ruka, tip penjanja