Ginszt Michał, Berger Marcin, Gawda Piotr, Marczak Milena, Ginszt Apolinary, Majcher Piotr. Electric activity of lumbar muscles in sport climbers. Journal of Education, Health and Sport. 2017;7(5):107-114. eISSN 2391-8306. DOI http://dx.doi.org/10.5281/zenodo.572310
http://ojs.ukw.edu.pl/index.php/johs/article/view/4447

The journal has had 7 points in Ministry of Science and Higher Education parametric evaluation. Part B item 1223 (26.01.2017).
1223 Journal of Education, Health and Sport eISSN 2391-8306 7

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 20.04.2017. Revised: 06.04.2017. Accepted: 06.05.2017.

Electric activity of lumbar muscles in sport climbers

Michał Ginszt[1], Marcin Berger[2], Piotr Gawda[3], Milena Marczak[4], Apolinary Ginszt[5], Piotr Majcher[6]

[1,3,5,6] Chair and Department of Rehabilitation, Physiotherapy and Balneotherapy, the Medical University of Lublin, Poland

[2] Department of Functional Masticatory Disorders, Medical University of Lublin, Poland

[4] Maria Curie-Skłodowska University, Lublin, Poland

Corresponding author:

Michał Ginszt

Address:

Magnoliowa 2

20-143 Lublin, Poland

+48602533723

michal.ginszt@umlub.pl

Acknowledgments

The results of the present study do not constitute an endorsement of the product by the authors or the journal.

Conflict of interest

The authors declare that they have no conflict of interest.

KEYWORDS: Surface Electromyography; Isometric Contraction; Muscle Fatigue; Sport climbing

ABSTRACT

Background: The synergy of all muscle groups seems to play crucial role in professional sport climbing. Climbing activity demands good balance and coordination between various parts of musculature. Unfortunately, this issue is an under-reviewed aspect in the literature.

Aim: The aim of this study was to compare the endurance-fatigue characteristics in rectus abdominals (RA) and erector spinae (ES) muscles during the isometric exercises performed by professional and amateur sport climbers.

Material and methods: We examined 50 healthy sport climbers (38 men, 12 women) aged 23 ± 3 years. Participants were divided into two groups: 25 professional and 25 amateur sport climbers. The International Climbing and Mountaineering Federation UIAA scale was used for classification: professional climbers > X-, amateurs < VII. The myoelectric activity of the RA and ES muscles was recorded simultaneously during isometric activity in a basic plank position.

Results: Significant differences in ES and RA muscles activity, between professional climbers and amateurs, were observed during trunk muscle strength tests in a basic plank position.

EMG median frequency was reduced from beginning to end of exercise (amateur climbers: RA - 23.40%, ES - 26.81%; professional climbers: RA - 19.69%, ES - 15.78%; $p < 0.001$).

Conclusions: Difference in muscle activity between professional and amateur sport climbers suggests that rectus abdominals and erector spinae muscles plays an important role in climbing.

INTRODUCTION

Core muscle stability (CMS) is defined as the ability to control the position and motion of the trunk over the pelvis to allow optimum production, transfer and control of force and motion to the terminal segment in integrated athletic activities (1). Studies suggest that lumbar muscles activity affecting CMS (erector spinae, abdominis muscles, gluteus, diaphragm in rear part, and hip muscles) is correlated with strength and performance in various sport activities (2–5).

Control of the position and motion are important factors for climbing movement. Climbers have to keep their body in imposed positions for prolonged time. (6) Climbing also demands good balance and coordination between various parts of musculature. Unfortunately, this issue is an under-reviewed aspect in the literature. There is insufficient amount of data from the studies demonstrating the influence of lumbar muscles training on performance outcome in specific sports, including sport climbing (7). The main goal of climbing training programmes is strengthening of upper body muscles (8). However, in our opinion training of lumbar muscles is also important as they provide proximal stability for distal mobility (9).

The aim of our study was to assess differences in rectus abdominals (RA) and erector spinae (ES) muscles between climbers on different sport levels, which may be useful for development of training programmes for sport climbers. Therefore, we assessed RA and ES muscle endurance by isometric tests in climbers on different levels of performance.

MATERIALS AND METHODS

Ethical issues

The study was approved by the ethical committee of Medical University of Lublin (KE-0254/339/2014). The study was conducted in accordance with the Declaration of Helsinki and all participants gave written informed consent.

Participants

We examined 50 healthy sport climbers (38 men, 12 women) aged 23±3 years. Climbers were divided into two equal groups: 25 elite climbers (19 men, 6 women) and 25 amateurs (19 men, 6 women). To classification was used International Climbing and Mountaineering Federation UIAA scale: elite climbers > X-, amateurs < VII. The characteristics of groups analysis did not show significant difference ($p>0.05$) in age, height and body weight between elite and amateur climbers. During a six-month period prior to the

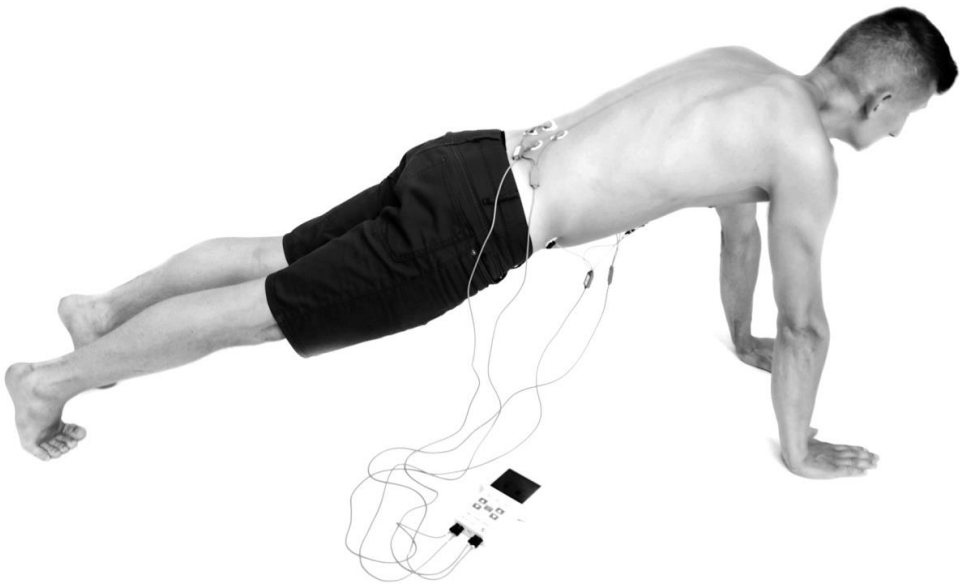
study, none of the study subjects had sustained any serious injuries that could affect the later test results. In order to decrease the influence of the variability of bioelectrical activity of the muscle during 24 hours, all the tests were conducted in the morning.

The measurement procedure

The 4-channel Noraxon MyoTrace 400, compatible with Master Edition, was used for the recording. The setting of the sEMG system during the measurement was based on sEMG for the Non-Invasive Assessment of Muscles (10). The surface electrodes (Ag/AgCl) were distributed to the muscle fibre direction of RA and ES muscles with the reference electrode on the anterior superior iliac spine. The space between the sEMG electrodes was 2.5 cm and each electrode had an 1.0 cm^2 pick-up area according to Ng et al. (11). The measurement was compiled from SENIAM standards. The skin under the electrodes was cleaned was cleansed with 90% ethyl alcohol solution.

Prior to data collection, each athlete performed a 10 minutes dynamic warm-up. After warm-up, the electrical activity of the RA and ES muscles was recorded simultaneously during isometric activity in a basic plank position as presented on Figure 1 (Fig.1). Participants were asked to take a basic plank position according to Tong et al. 2014 (12). During the test, each participant was asked to stand still for 60 seconds.

Figure 1. sEMG measurement during isometric activity in a basic plank position



Evaluated parameters

The raw signals from the sEMG measurement are interpreted through fast fourier transform using software available in the sEMG system to determine muscle fatigue (13) Spectral median frequency (MF) was compared between the beginning second and the final second of tests.

Data analysis

Statistical analysis of differences between compared variables was done using t-Student test for independent samples. The level of significance was set at $p = 0.001$. Data were analysed using IBM SPSS 21 software.

RESULTS

EMG spectral median frequency during isometric contraction of the RA muscles decreased by 19.69% for elite climbers and 23.4% for amateurs (table 1).

EMG spectral median frequency of the ES muscles decreased by 15.78% for elite climbers and 26.81% for amateurs (table 1).

Table 1. Mean spectral median frequency differences between professional and amateur climbers during isometric test

Muscle group	Climbers	Mean fft difference	SD	t	p
Rectus abdominis	Professional climbers	19.69	2.63	- 4.65	< 0.001
	Amateur climbers	23.40	4.76		
Erector spinae	Professional climbers	15.78	3.00	- 9.8	< 0.001
	Amateur climbers	26.81	3.02		

DISCUSSION

Lumbar muscles training is gaining in popularity in many sportsmen and have been shown to be imperative for initiation of functional limb movements, as needed in athletics (14). Sports medicine practitioners use core-strengthening techniques for lumbar muscles to improve performance and prevent injury (14). Moreover, exercises that restore and enhance

core stability are related to injury prevention and rehabilitation (9).

Our aim was to determine whether lumbar muscles endurance is correlated with the level of climbing ability. Significant differences in ES and RA muscles activity, between professional climbers and amateurs were observed during test in a basic plank position. Our results showed that professional climbers have better ES and RA muscles endurance than amateur climbers. Thus, the use of lumbar muscles training in sport climbing may influence the quality of climbing. Moreover, lumbar muscles training can be a good supplemental training not only for improving climbing performance, but also to reduce injury risk.

We identified only two studies evaluating the relationship between lumbar muscles and climbing performance. In the study by Macdonald and Callender (2011) abdominal muscle endurance, assessed by isometric tests, was compared between highly accomplished climbers and non-climbers. In contrast to our result, core endurance was not significantly different between climbers and controls (18). Similar results were noted by Deyhle et al. (2015), who evaluated the influence of lumbar flexors fatigue on climbing performance. They found no significant differences in climbing performance between climbs with and without pre-fatigue of the lumbar flexors (19). Different outcome in these studies, compared to our study, could possibly result from differences in methodology. Dayhle et al. (2015) also used sEMG to assess muscle fatigue. However, their sample size was significantly smaller comparing to ours. Moreover, electric muscle activity was measured during climbing ascent, which could have influenced the outcome.

In summary, according to our findings, we can assume that lumbar muscles endurance is possibly one of the factors determining success in sport climbing. However climbing performance is influenced by many physiological and psychological components, as suggested by the model of Goddard and Neumann (20).

CONCLUSIONS

The erector spinae and rectus abdominal muscles endurance is associated with better climbing performance, thus training programmes for climbers should include exercises to strengthen the lumbar muscle stability.

REFERENCES

1. Kibler WB, Press J, Sciascia A. The role of core stability in athletic function. Sports Med

Auckl NZ. 2006;36(3):189–98.

2. Granacher U, Schellbach J, Klein K, Prieske O, Baeyens J-P, Muehlbauer T. Effects of core strength training using stable versus unstable surfaces on physical fitness in adolescents: a randomized controlled trial. BMC Sports Sci Med Rehabil. 2014;6(1).

3. Hoshikawa Y, Iida T, Muramatsu M, Ii N, Nakajima Y, Chumank K, et al. Effects of stabilization training on trunk muscularity and physical performances in youth soccer players. J Strength Cond Res Natl Strength Cond Assoc. 2013;27(11):3142–9.

4. Nesser TW, Huxel KC, Tincher JL, Okada T. The relationship between core stability and performance in division I football players. J Strength Cond Res Natl Strength Cond Assoc. 2008;22(6):1750–4.

5. Yu S-H, Park S-D. The effects of core stability strength exercise on muscle activity and trunk impairment scale in stroke patients. J Exerc Rehabil. 2013;9(3):362–7.

6. Horst E. Maximum Climbing: Mental Training for Peak Performance and Optimal Experience. Guilford: Rowman & Littlefield; 2010.

7. Reed CA, Ford KR, Myer GD, Hewett DTE. The Effects of Isolated and Integrated 'Core Stability' Training on Athletic Performance Measures. Sports Med. 2012;42(8):697–706.

8. Laffaye G. Determinant factors in climbing ability: influence of strength, anthropometry and neuromuscular fatigue. Scand J Med Sci SPORTS. 2015.

9. Huxel Bliven KC, Anderson BE. Core Stability Training for Injury Prevention. Sports Health. 2013;5(6):514–22.

10. Hermens HJ, Freriks B, Disselhorst-Klug C, Rau G. Development of recommendations for SEMG sensors and sensor placement procedures. J Electromyogr Kinesiol Off J Int Soc Electrophysiol Kinesiol. 2000;10(5):361–74.

11. Ng JK, Kippers V, Richardson CA. Muscle fibre orientation of abdominal muscles and suggested surface EMG electrode positions. Electromyogr Clin Neurophysiol. 1998;38(1):51–8.

12. Tong TK, Wu S, Nie J, Baker JS, Lin H. The Occurrence of Core Muscle Fatigue During High-Intensity Running Exercise and its Limitation to Performance: The Role of Respiratory Work. J Sports Sci Med. 2014;13(2):244–51.

13. Halim I, Omar AR, Saman AM, Othman I. Assessment of Muscle Fatigue Associated with

Prolonged Standing in the Workplace. Saf Health Work. 2012;3(1):31–42.

14. Akuthota V, Ferreiro A, Moore T, Fredericson M. Core stability exercise principles. Curr Sports Med Rep. 2008;7(1):39–44.

15. Atkins S. Electromyographic response of global abdominal stabilisers in response to stable- and unstable-base isometric exercise. J Strength Cond Res Natl Strength Cond Assoc. 2014.

16. Campbell BM, Kutz MR, Morgan AL, Fullenkamp AM, Ballenger R. An evaluation of upper-body muscle activation during coupled and uncoupled instability resistance training. J Strength Cond Res Natl Strength Cond Assoc. 2014;28(7):1833–8.

17. Willardson JM. Core stability training: applications to sports conditioning programs. J Strength Cond Res Natl Strength Cond Assoc. 2007;21(3):979–85.

18. Macdonald JH, Callender N. Athletic Profile of Highly Accomplished Boulderers. Wilderness Environ Med. 2011;22(2):140–3.

19. Deyhle MR, Hsu H-S, Fairfield TJ, Cadez-Schmidt TL, Gurney BA, Mermier CM. The Relative Importance of Four Muscle Groups for Indoor Rock Climbing Performance. J Strength Cond Res Natl Strength Cond Assoc. 2015.

20. Watts PB. Physiology of difficult rock climbing. Eur J Appl Physiol. 2004;91(4):361–72.