

ASSESSMENT OF MORPHOLOGICAL ARCHITECTURE OF FEET IN ROCK-CLIMBERS

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Abstract. It was hypothetically assumed that rock-climbers have normal foot structure. The aim of this study was to assess the structure of all the foot segments. Materials and methods: This study embraced 43 rock-climbers, who had been training for 3 to 7 years. The research group included 17 women and 26 men, aged from 18 to 24 years (mean age – 24.3). The control group consisted of 31 students of the University of Wrocław, aged from 19 to 23 years (mean age – 22.7). Photometric method was used to examine the morphological structure of the feet. Results Results of the examinations show that all the rock-climbers had normal structure of the longitudinal arch, while various types of the longitudinal arch structure were observed in the students. The analysis of the transversal arch structure showed that disorders were more frequent in the rock-climbers. Conclusions. 1 Rock-climbing has a beneficial influence on the structure of the longitudinal arch, yet it is the factor facilitating disturbances of the frontal foot segments. 2 Deformations of the transversal arch structure and the toes arrangement do not coexist with the longitudinal platypodia.

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Introduction

Static overloading and overweight are thought to be the most frequent causes for disorders of the morphological structure of feet [4,7]. Moreover, there is a common view that deformations in the frontal area of the foot result from longitudinal platypodia [1,6]. It seems that rock climbing, as a sport, eliminates the two fundamental factors disturbing normal structure of the foot. Rock-climbers are of slim build and intense training activates their lower limbs' muscles.

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Materials and Methods

This study embraced 43 rock-climbers, who had been training for 3 to 7 years. The research group included 17 women and 26 men, aged from 18 to 24 years (mean age – 24.3). All the subjects were of slim build. The control group consisted of 31 students of the University of Wrocław, aged from 19 to 23 years (mean age – 22.7). Among the student, 73.81% were of slim build, 16.67% were of medium built and 9.52% were of massive build according to Rohrer.

Photometric method was used to examine the morphological structure of the feet and the results were classified according to Demczuk-Włodarczyk classification [2,3].

An individual assessment of the structure of the longitudinal and transversal arches and of the position of toes was made. Two test positions were assumed: sitting (feet unloaded) and standing (feet loaded).

- Regularity of the longitudinal arch structure was determined by comparing the height of the 5 longitudinal arches of the foot in statodynamic conditions.
- The transversal arch's structure and the arrangement of the toes were assessed basing on an analysis of pressure of the toes and the instep bones' heads on the podoscope panel.

Statistical characteristics of the analysed traits were presented as the occurrence frequency of individual types of the longitudinal and the transversal arch structure, and the regularity of toes placement in both of the examined groups. Group I was the research group and Group II was the control group.

Results

Characteristics of the longitudinal arch: Results of the examinations show that all the rock-climbers had normal structure of the longitudinal arch, while various types of the longitudinal arch structure were observed in the students. (Table 1).



Table 1

Frequency of the individual types of the longitudinal arching structure

Longitudinal arch structure type	Group I	Group II
normal arch	100%	87.27%
excessive arch	0%	3.51%
at risk of platypodia	0%	8.77%
platypodia	0%	0.47%

Characteristics of the transversal arch: The analysis of the transversal arch structure showed that disorders were more frequent in the rock-climbers. (Table 2).

Table 2

Frequency of the transversal platypodia

Transversal arch structure type	Group I	Group II
normal arch	62.8%	79.63%
transversal platypodia	37.2%	20.37%

Characteristics of the toes arrangement: The results of the toes' arrangement assessment, basing on the intensity of the toes-to-surface adhesion, are presented in Table 3.

Table 3

Frequency of abnormal toe-to-surface adhesion

Toes	Group I	Group II
II	22.56%	11.52%
III	9.3%	0%
II & III	15.80%	0%
V	18.14%	0%

The analysis of these results showed greater frequency of abnormal toes-to-surface adhesion in the rock-climbers. Reduced adhesion concerned: most



often the 2nd and the 5th toe and least often the 3rd toe. On the other hand, abnormal adhesion was observed only in the case of the 2nd toe.

Discussion

Rock-climbing, as any other sports discipline, activates the motor system in a specific way. The climbers climb up the rock using mostly their hands and feet, as ropes and other equipment are used only for the sake of safety. Therefore, practising this sport requires strong hands and feet. It may be assumed that climbing up a rock by supporting one's feet against protrusions, cracks or any uneven surfaces should considerably strengthen the long muscles of shanks. The analysis of the longitudinal arch structure in the rock-climbers confirmed this assumption. Normal structure of the longitudinal arch was observed in all the climbers. On the contrary, abnormalities of the structure of the longitudinal arch were stated in the students group.

The analysis of the frontal segments of the foot shows other results. Higher frequency of abnormal structure of the transversal arch and disorders of the toes' arrangement was observed in the rock-climbers. However, such a high frequency of the transversal platypodia in the rock-climbers cannot be explained by over-weight or defective longitudinal arch structure, as they were all of slim build and showed normal structure of the longitudinal arch.

Yet, one may think that using special footwear is one of the reasons for the higher frequency of disorders of the frontal foot area. While training, climbers use, so called, asymmetric footwear, which means that it is one size smaller than their usual footwear. This enforces bending of the toes and unloading of the head of the 1st metatarsus bone. Such a change of the foot's shape alters distribution of the foot-to-surface pressure allowing one to concentrate it in the frontal area of the foot. This increases adhesion and improves sensing of any irregularities of the rock's surface. On the other hand, it seems to be the factor disturbing the 3D, helical structure of foot. According to Larsen's [5] conception of helical dynamics, a normally built foot resembles a helix. Its segments are rotated in opposite directions around its longitudinal axis i.e. the rear segment is rotated outwards and the front segment is rotated inwards. Such a structure of the foot ensures proper anatomical conditions for the functioning of muscles. Bending of the toes and unloading of the head of the 1st metatarsus bone, however, enforces the front foot segment to rotate outwards. One may say that it is the primary link in the pathological chain of disturbances of the frontal foot segment observed by the author in her studies.



Higher frequency of anomalies of the transversal arch structure as well as of the arrangement of the toes in the rock-climbers seems to confirm this assumption.

Disturbance of force distribution in one of the frontal foot segments produces changes in the neighbouring segment. Following the viewpoint of biomechanics, it may be said, that the frontal support plane, which includes the metatarsus bones' heads and toes, shows a physiological hierarchy of loads and pressure. Having analysed the changes of the 3D structure of the feet of the rock-climbers while climbing, it was observed that the unloading of the 1st metatarsus bone enforced by wearing of the asymmetric footwear leads to weakening of the long, sagittal muscle, which is responsible for pressing of this head toward the surface. It may be thought, that the described changes influence the frequency of the disorders of the frontal segments of the foot.

The analysis of frequency of anomalies in the structure of the individual segments of the foot in the rock-climbers allows one to think that despite the functional unity of all the foot segments, the transversal platypodia is not accompanied by disturbances of the longitudinal structure of the foot. The results obtained in this study do not confirm the reports saying that deformations of the frontal foot segments are the consequence of the longitudinal platypodia. Thus, one can say that this relationship applies to the deformities of the frontal segments of the foot.

Conclusions

1. Rock-climbing has a beneficial influence on the structure of the longitudinal arch, yet it is the factor facilitating disturbances of the frontal foot segments.
2. Deformations of the transversal arch structure and the toes arrangement do not coexist with the longitudinal platypodia.

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