Variability of ankle movements as a fatigue factor in runners

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Postgraduate student **E.S. Negodenko**[1, 2]
E.V. Medvedeva[1]
Dr. Med., Professor **L.V. Kapilevich**[1, 2]
[1]National Research Tomsk State University, Tomsk
[2]National Research Tomsk Polytechnic University, Tomsk

Corresponding author: kapil@yandex.ru

Abstract

Objective of the study was to assess the stability of the ankle trajectory in runners of various qualifications under conditions of fatigue.

Methods and structure of the study. During the study, two groups were formed: a group of highly qualified runners - 8 people (4 men and 4 women) with more than 5 years of trail running experience, age 30±3 years, average preferred running speed 13±1.33 km/h; without injuries for the past and current calendar year. Control group - novice runners - 10 people (7 men and 3 women) with half a year experience of smooth running on asphalt/hard ground, age 18±2 years, speed in the mixed pulse zone 7±2.2 km/h.

The movement registration method was used to study the instability of the ankle trajectory in runners of various qualifications under conditions of fatigue.

Results and conclusions. It is shown that fatigue that develops during long-term running loads (45 minutes) is accompanied by an increase in the variability of ankle movements, and if this increase is not so significant for experienced athletes, then for beginner runners it is very significant and can serve as a risk factor for sports injuries. This aspect must be taken into account when planning the training process, when choosing sports shoes and when assessing the risk of injury.

Keywords: *running, kinematics, ankle, sports injury.*

Introduction. Running is the standard and most common type of training activity. Along with the significant health benefits of running in various age groups, running comes with a high risk of injury. The risk of injury increases gradually - without special exercises, which often happens with independent runners, running acts as a delayed (accumulated) damaging factor. The frequency of sports injuries during excessive exercise is quite high [5, 6]. Violations of the biomechanics and kinematics of the athlete's movements during fatigue are considered important risk factors.

In most cases, runners choose a running pace (frequency of steps) that provides the minimum energy expenditure [1, 4]. Also, an important factor in running is maintaining a constant phase structure of movements - each cycle should repeat the previous one. Due to the peculiarities of the functioning of the neuromuscular apparatus, it is prone to repeated repetition of stable cyclic movements [2].

In case of violation of the structure of the cycle for any reason (external - uneven structure of the supporting surface or shoe defects; internal - desynchronization of the leg muscles), it is necessary to apply additional muscle efforts to maintain a constant trajectory of the foot and its interaction with the surface [3, 6]. But the ability to adequately respond to such changes is formed only in experienced athletes.

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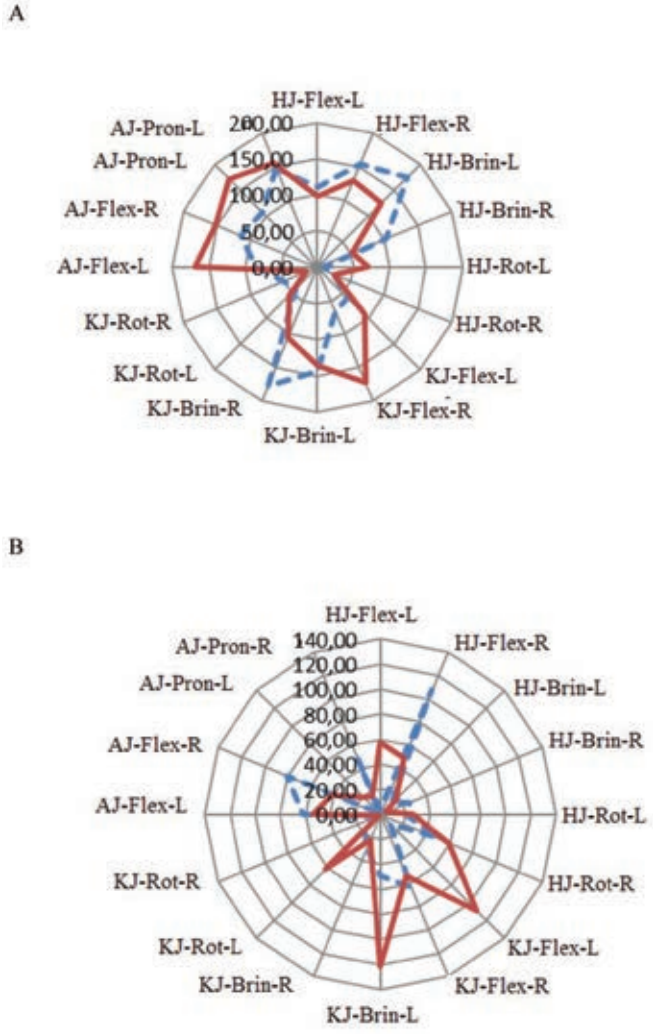
Fixation of the position of the hip, knee, ankle joints was carried out using the hardware-software complex "Trust - M") (Russia), version 2.12.x. The device, using sensors connected via wi-fi, including channels for recording Euler angles relative to the zero position, allows you to register the position of the body in space and measure the angular and temporal characteristics of joint movements during physical activity, as well as average data on the time of a running step. For visual control of the running technique, frame-by-frame shooting was carried out in the sagittal plane.



Picture 1. *Indicators of maximum range of motion in the joints of experienced (A) and beginners (B) runners (mm).*

The solid line is before the running load.

The dotted line is after 45 minutes of running.

Designations: HJ – hip joint; KJ – knee-joint; AJ – ankle joint; Flex – flexion; Brin – bringing; Rot– rotation; Pron – pronation; L – left; R – right

The design of the study implied the fixation of three-dimensional kinematics at regular time intervals for a three-minute run on a treadmill at a speed corresponding to the mixed anaerobic pulse zone (in the range from 145 to 155 depending on the age of the athlete) before and after a 45-minute running session in that same pulse zone. The pulse zone was recorded using a Polar watch with the function of fixing the required heart rate and a chest strap, which ensures accuracy in measuring heart rate. The average, peak angles of the joints in the hip, knee and ankle joints, the time of the phases of the maximum amplitude of the joints during the control three-minute running session before and after the 45-minute training load in the mixed pulse range were recorded.

Results of the study and their discussion. The results obtained are shown in Figure 1. It is noteworthy that highly qualified runners' movements are characterized by symmetry, which is preserved after a running load. Changes after loading are present but not significant (Figure 1A). A fundamentally different picture in novice runners (Figure 1B) - the asymmetry of movements, expressed at the beginning of the run, significantly increases at the 45th minute. In general, after the load, pronounced violations of the structure of the motor cycle are noted.

Advanced runners showed significant increases in right knee and both ankle flexion, while control runners increased left knee adduction and left hip flexion. In relation to other indicators, beginners are characterized by a decrease in the maximum amplitude of angles after a running session, in addition, the trend of being in the phase of maximum joint flexion and pronation amplitudes for 1 cycle after a running session by 20% increased among beginner runners, which indicates a decrease in the efficiency of running equipment , an increase in the time for performing flexion locomotions, an increase in the ankle joints in a pronated state, and a knee joint in an extended state, which can cause some injuries of the lower limb (excessive rotation can have a particularly significant effect on the talocalcaneal joint), resulting from the accumulation of stress with a subsequent decrease in the function of adductors and extensors

of the thigh, pronators of the foot. Advanced runners also showed an increase in the trend of being in the phase of maximum amplitudes by an average of 10% for all indicators, which indicates the overall effect of fatigue on the decrease in the speed of the muscles of the lower limb. The absence of pronounced differences in the stability of maximum amplitude indicators, a more even distribution of joint performance indicators in the maximum amplitude phase of advanced runners after a running session (with the exception of flexion and rotation indicators of the left knee joint) in comparison with beginner runners indicates the importance of the stability factor of ankle kinematic parameters in qualified runners athletes.

Conclusions. The results obtained indicate that fatigue that develops during long-term running loads (45 minutes) is accompanied by an increase in the variability of ankle movements, and if this increase is not so significant for experienced athletes, then for beginner runners it is very significant and can serve as a risk factor for sports injuries. This aspect must be taken into account when planning the training process, when choosing sports shoes and assessing the risk of injury. To prevent injuries, exercises aimed at strengthening the inverters of the ankle joint and the hip abductors can be recommended.

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