

The state of viscoelastic properties of muscles in athletes with visual impairment during the competitive period

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Abstract

Objective of the study was to identify the viscoelastic properties of muscles in athletes with visual impairment of classes B1, B2 and B3 before and after running 60m during the competitive period, to determine the functional characteristics of muscles associated with training and gender.

Methods and structure of the study. The study was conducted as part of the state task, during the All-Russian athletics competitions (sport of the blind) in Chelyabinsk in February 2023. Athletes with visual impairment before and after the 60 m race were measured viscoelastic properties of muscles. Measurement of myotonometry parameters of the rectus femoris muscle (RFM) and the lateral head of the gastrocnemius muscle (LHGM) was carried out using the MyotonPRO device before and after the competitive exercise.

Results and conclusions. It was revealed that after running 60 meters in athletes with visual impairment of classes B1, B2 and B3, there is a tendency to reduce tone and stiffness, increase elasticity, relaxation time and fluidity. The study showed that the higher the qualification of a sprinter with visual impairment in the study group, the lower the stiffness, but the higher the relaxation time, both at rest and after running 60 m. relaxation and fluidity, and after running higher elasticity.

Keywords: *myotonometry, sports of visually impaired persons, sports of the blind, running, athletics.*

Introduction. According to scientific literature, understanding the viscoelastic properties of muscles is of great interest in the field of physical culture and sports. Most of the works devoted to myotonometry (MTM), the results of which can be integrated into sports activities, concern studies of healthy people [1, 2, 3, 4].

Evidence from the scientific literature suggests that increased levels of stiffness are associated with a higher risk of stress injury. The higher the values of "F" and "S" (stress state F - oscillation frequency (Hz) characterizes the tone; dynamic stiffness S (N/m) - resistance to contraction or external force), the greater the tension and stiffness of the studied structure of soft tissues in special body measurement points. The

lower the value of "D" (decrement of elasticity D (c.u.) - tissue elasticity), the less mechanical energy is dissipated during vibrations and the higher the elasticity of the muscle, tendon or fascia. Optimal indicators, reflecting the viscoelastic properties of muscles, indicate a good functional state of the muscle, its ability to voluntary relaxation, a rapid decrease in tension tone and the course of recovery processes; the greatest changes in the viscoelastic properties of muscles are observed in the stubborn thigh and gastrocnemius muscles [4, 2, 6, 5].

As a rule, the functionality of the musculoskeletal system during the competitive period reflects its readiness to perceive the maximum load.

**Table 1.** Groups of athletes with visual impairment (visually impaired)

Group	Boys-masters		Boys-rankers		Girls		Boys	
Sample size (n)	10		10		9		9	
Age ($x \pm Sx$)	21,6 \pm 1,2		19,8 \pm 1,6		15,6 \pm 0,6		17,5 \pm 0,8	
Qualification	CMS	MS, MSIC	1-3 youth sports category	1-3 sports category	CMS	Discharge	CMS	Discharge
Number of persons	5	5	4	6	2	7	2	7

Note: CMS - candidates for master of sports; MS - masters of sports; MSIC - masters of sports of international class; x - sample arithmetic mean; Sx is the standard error of the arithmetic mean

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Table 2. Parameters of myotonometry in young masters and young athletes

Options		F	S	D	R	C	F	S	D	R	C
LHGM											
Youths		right to					left to				
M	Me	14,6	262,0	1,2	21,1	1,3	14,0	255,0	1,2	21,7	1,3
	σ	1,1	25,3	0,3	2,1	0,1	1,2	28,3	0,4	2,0	0,1
P	Me	14,2	260,0	1,3	21,8	1,3	14,4	253,0	1,2	21,1	1,3
	σ	1,5	25,8	0,2	2,9	0,2	1,2	27,7	0,2	2,9	0,2
P-value		-	-	-	-	-	-	-	-	-	-
Youths		right after					left after				
M	Me	13,1	237,0	1,3	24,4	1,5	13,2	226,0	1,2	23,5	1,4
	σ	1,2	29,3	0,2	2,4	0,1	1,1	24,6	0,1	2,3	0,1
P	Me	14,1	255,5	1,3	22,9	1,4	14,2	251,0	1,2	21,8	1,4
	σ	1,4	24,0	0,3	2,1	0,1	1,1	27,9	0,2	1,8	0,1
P-value		-	-	-	-	-	-	-	-	-	-
Options		F	S	D	R	C	F	S	D	R	C
RFM											
Youths		right to					left to				
M	Me	15,5	265,0	1,3	19,7	1,2	14,9	262,0	1,3	20,1	1,2
	σ	1,5	25,0	0,3	1,8	0,1	1,2	21,8	0,2	1,6	0,1
P	Me	16,9	318,0	1,6	16,4	1,0	17,5	316,0	1,3	17,0	1,0
	σ	1,4	31,3	0,2	1,9	0,1	2,6	60,5	0,2	3,2	0,2
P-value		-	0,01	-	0,01	0,01	-	0,03	-	0,02	0,02
Youths		right after					left after				
M	Me	15,0	253,5	1,4	20,0	1,2	14,8	250,0	1,5	20,8	1,3
	σ	2,2	48,4	0,2	2,4	0,1	1,5	31,9	0,2	1,9	0,1
P	Me	16,3	302,0	1,4	17,3	1,1	17,2	311,5	1,4	16,9	1,0
	σ	1,6	28,3	0,3	1,8	0,1	1,7	29,9	0,3	1,8	0,1
P-value		-	-	-	-	-	0,02	0,01	-	0,003	0,004

Notes: RFM - rectus femoris muscle; M - young men-masters of sports; R - young men-dischargers; Me is the median; σ is the standard deviation; P-value - level of significance; F - oscillation frequency (Hz) characterizes the tone; dynamic stiffness S (N/m) - resistance to contraction or external force; elasticity decrement D (conventional unit) - tissue elasticity; relaxation time of mechanical stress R (ms) - the time at which the muscle restores its shape after deformation from an arbitrary contraction; C (conventional unit) - fluidity (Deborah's number).



Table 3. Parameters of myotonometry in girls and boys

Options		F	S	D	R	C	F	S	D	R	C
LHGM											
G-B		right to					left to				
	Me	12,9	217,0	1,3	24,2	1,5	12,8	213,0	1,0	24,6	1,5
	σ	0,8	23,9	0,2	1,3	0,1	0,5	20,3	0,2	1,5	0,1
B	Me	14,4	270,0	1,3	21,0	1,3	14,5	25,04	1,2	20,7	1,3
	σ	1,2	32,4	0,2	2,9	0,2	1,4	32,9	0,2	2,6	0,2
P-value		0,03	0,02	-	-	-	-	-	-	0,04	0,02
RFM											
G-B		right after					left after				
G	Me	12,4	206,0	1,1	25,2	1,5	12,4	214,0	1,2	24,5	1,5
	σ	1,0	30,2	0,2	1,9	0,1	1,1	30,1	0,2	2,1	0,1
B	Me	13,7	255,0	1,2	23,3	1,5	13,4	248,0	1,3	23,6	1,4
	σ	1,5	34,4	0,3	2,6	0,1	1,5	35,0	0,2	2,8	0,2
P-value		-	-	0,02	-	-	-	-	-	-	-
Options		F	S	D	R	C	F	S	D	R	C
LHGM											
G-B		right to					left to				
G	Me	16,1	279,0	1,4	17,7	1,1	15,8	278,0	1,3	18,9	1,2
	σ	1,8	30,9	0,3	2,3	0,1	1,4	27,4	0,1	1,7	0,1
B	Me	15,8	267,0	1,2	18,6	1,1	15,6	274,0	1,3	17,6	1,0
	σ	1,2	34,2	0,3	2,2	0,1	2,6	52,1	0,2	2,9	0,2
P-value		0,03	-	-	-	-	-	-	-	-	-
G-B		right after					left after				
G	Me	15,4	264,0	1,2	18,8	1,1	15,3	279,0	1,2	18,4	1,1
	σ	1,4	42,4	0,2	2,2	0,1	1,0	31,8	0,1	1,6	0,1
B	Me	16,1	294,0	1,2	17,1	1,1	16,4	299,0	1,4	17,1	1,1
	σ	1,8	40,0	0,3	2,5	0,1	2,2	44,3	0,3	2,8	0,2
P-value		-	-	-	-	-	-	-	-	-	-

Notes: LHGM - lateral head of the gastrocnemius muscle; G - girls; B - boys; Me - median; σ is the standard deviation; P-value - level of significance; F - oscillation frequency (Hz) characterizes the tone; dynamic stiffness S (N/m) - resistance to contraction or external force; elasticity decrement D (c.u.) - tissue elasticity; relaxation time of mechanical stress R (ms) - the time at which the muscle restores its shape after deformation from an arbitrary contraction; C (c.u.) - fluidity (Deborah's number).

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Stratified samples included 38 athletes, a more detailed distribution by groups is presented in Table 1. Statistical analysis of the data was carried out using the STATISTICA 10 software package, and the Mann-Whitney test was used to compare two independent samples.

Results of the study and their discussion.

When comparing the indicators of viscoelastic properties of the lateral head of the gastrocnemius muscle (LHGM) at rest and after a competitive exercise, no significant differences were found in male masters and male athletes (Table 2). After running, there is a trend towards a decrease in tone and stiffness, but an increase in elasticity, relaxation time and fluidity, which is consistent with literature data.

Significant differences were revealed in the viscoelastic properties of RFM at rest in young men, depending on the level of their qualification. So, in young masters, muscle stiffness is significantly lower than in young athletes, but the relaxation time and fluidity are higher both on the right and on the left side. After running 60 m only on the left side, the young masters showed a lower tone, stiffness, higher relaxation time and fluidity. The obtained differences between the indicators of masters and sportsmen may indicate a higher adaptation to the competitive load and higher reserves of muscle recovery in more highly qualified athletes. The higher the qualification of a sprinter with visual impairment who took part in the competition, the lower the relaxation both at rest and after a 60m run, as evidenced by the obtained statistically significant differences in RFM. This trend was also revealed by the LHGM.



It has been established that girls, unlike boys, have lower tone and stiffness of LHIM, but higher relaxation time and fluidity. Statistically significant differences in the tone and stiffness of the LHIM at rest on the right, relaxation time and fluidity on the left (Table 3) were revealed. difference from girls after a competitive exercise.

Differences in indicators of the viscoelastic properties of RFM in girls and boys have not been established, which indicates approximately the same functional state of the viscoelastic properties of muscles, regardless of gender in this group.

Conclusions. It was revealed that after running 60 meters in athletes with visual impairment of classes B1, B2 and B3, there is a tendency to reduce tone and stiffness, increase elasticity, relaxation time and fluidity.

At rest, young masters have significantly lower stiffness, but higher relaxation time and fluidity of the rectus femoris muscle than young athletes. After running, young masters have lower tone, stiffness, higher relaxation time and fluidity on the left side, in contrast to young athletes. Significant differences were determined by the indicators of the viscoelastic properties of the left leg, which in the majority of all examined athletes is a jerk.

At rest, girls showed significantly lower values of tone and stiffness of the lateral head of the gastrocnemius muscle on the right, but higher values of relaxation time and fluidity on the left, in contrast to boys. After running 60 m, significant differences were established by the decrement of elasticity on the right side, which indicates a greater elasticity of muscle tissue in boys, unlike girls, after a competitive exercise.

The study showed that the higher the qualification of a sprinter with visual impairment in the study group, the lower the stiffness, but the higher the relaxation time, both at rest and after running 60 m. relaxation and fluidity, and after running higher elasticity.

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