MOVEMENT FORMATION AFTER INJURIES OF MOTOR-SUPORT SYSTEM FOR THE RUNNERS OF MIDDLE AND LONG DISTANCES

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The reason for this research was to investigate the effects of clinical rehabilitation movement limitations on the sportsmen as it influences negatively the functions of motor-suport system (MSS) and increases the period of rehabilitation.

It was supposed that after movement mechanism cognition of injured and sound limbs in the process of running methodical possibilities are revealed for constructing not only the movement, but also the totality of conditions...(RATOV, 1987), for injured limb correction (rehabilitation)...(RATOV, PAVLOV, 1987) can be studied.

There are few works directed at studying movements of an injured limb in the process of running. There are even less works devoted to the movement control of athletes in running with the aim of motor-support system functions' rehabilitation.

The purpose of this study is to investigate the biomechanical movement peculiarities of an athlete in the process of running under pathological disorders of motor-support system, to study their formation possibilities in artificially made conditions and to determine practical efficiency in the rehabilition process after the undergone trauma.

METHODS

Biomechanical movement parameters of 25 athletes on middle and long distances were studied and compared for the purpose of investigation of characteristic biomechanical movement regularities of the MSS injured link of an athlete and the quest for pedagogical methods which make it possible to exclude the movement structure disorders, create conditions for the full-bodied training and lead to rehabilitation of injured limb work capacity.

To determine the differences in movements of the lower extremities we have investigated the cases of minor knee and ankle injuries (microtraumas, meniscus, ligaments, Achilles tendon bursitis) which were not accompanied by sharp pains and did not interfere with athlete's training on the treadmill with speed of running from 3.0 to 6.0 m/sec. for an interval of 0.5 min.

Flight and support periods were measured by means of a supportless optic electronic system; shock wave propagation along lower extremities was determined by accelerometer "Bruel &Kj r" fixed on different parts of the body. Kinematic characteristics were estimated by "Actionmaster-500" camera with subsequent film analysis by "Nac Sportias". Electrical muscle activity of lower extremities was registered by myograph of "Medicor" firm. Biopotential analysis of lower extremities was performed by analogue computer ABK-31 immediately at the time of the experiment.

The frequency of systole was measured by "Sport-4" system with parallel cardiac cycle fixation and subsequent analysis.

Strength and speed-power capacity of thigh, ankle and foot flexors and extensors were determined before the investigation.

As one of artificially created conditions for running technique correction and rehabilitation was the "force gravity limitation" (FGL) method allowing to reduce the gravity influence at particular degrees (in % of body weight of an athlete) by means of draught which is directed upward vertically.

For strengthening of weak muscle the electrostimulation was, used which was prepared beforehand according to the sound limb electromyographical movement model. Electrostimulating signal characteristics were chosen personally for each athlete; the signal was performed with the use of the analogue computer.

Preliminary analysis of received data on the basis of three experimental and one control groups made it possible to outline ways and conditions of using indicated methods in running for correction and rehabilitation of MSS functions in runners on middle and long distances.

I group - 12 top runners with knee injuries;
II group - 15 low qualified runners with knee injuries;
III group - 13 top runners with pathology of ankle joints;
IV group - 12 top runners with knee pathology.

Sportsmen of the control group trained according to generally accepted methods as the injured leg permitted. Experimental group sportsmen trained every other day using the methods mentioned above (Tab.1).

RESULTS

Significant decrease of strength and speed-power of the thigh, ankle and foot flexors and extensors capacity was observed in case of ankle joint injuries and Achilles tendon bursitis (up to 15-30%). Decrease of strength and speed-power capacity of ankle extensors and thigh flexors (22-50%) in the case of knee joint and ligament injuries to a certain extent was compensated by strength increase of foot flexors and thigh extensors (from 7 to 24%). In the process of running, the movements of an injured leg were characterized by less (6%) support and greater flight (by 4%) phases, greater values (20-40%) of shock (vertical acceleration) and lesser (15-30%) values of horizontal shock (acceleration). The injured leg is characterized by decreased capacity to reduce (to absorb) the shock loads. Greater flexion of all joints of an injured leg (by 5-12%) during absorbtion phase resulted in more intensive vertical oscillations of general centre of gravity (10).

Gastrocnemius muscles of injured extremities are characterized by less electroactivity, the other muscles show increased total electroactivity in running.

On the basis of pedagogical observations, the analysis of dynamic changes of parameters, rate of their reduction depending on the increase of speed in the process of running and fatique it was stated that more information meaning connecting biomechanical movement parameters of injured and sound legs resulted through the creation of "comfortable" conditions.

The greatest efficiency of the FGL method was found out in running with the speed from 3.0 to 5.0 m/sec with decreasing the force of gravity by 20% from an athlete's body weight.

The difference in biomechanical parameters is not reduced only by their absolute value on each speed of running (3,4,5 m/sec), but the dynamics of their increase also becomes smoother with the increase in speed from 3.0 to 5.0 m/sec.

While using the force gravity limitation method the difference with increase from fatigue is not significant.

Such characteristics of artificial decrease in biomechanical parameter difference between injured and sound legs was discovered even during muscle activization of injured leg by means of electrostimulation which was carried out at the moment when the sound leg was put on the support with delay of support from 20-50 m/sec to 200-300 m/sec on signal amplitude from 100 to 400 volts.

However, when using FGL method the difference between parameters increased as running duration increased, then while using electrostimulation during the first five minutes of running. Even at the finish the difference of parameters also increased, but in less degree than without electrostimulation.

Thus the most reasonable conditions for the use of this method is while running with a velocity of 3 to 5 m/sec with 5 minutes of duration.

The highest efficiency was displayed when both methods - FGL and electrostimulation - were used. On the growth of running velocity and owing to fatigue the change parameter dynamics of the injured and sound legs is on the whole similar to simultaneous use of FGL and electrostimulation as it is when only EMS is used but the influence efficiency is higher.

RESULTS

- of the pedagogical experiment proved the hypothesis put forward. It was confirmed that using the method of muscle artificial activation carried out on the basis of EMS and FGL increases significantly the rehabilitation rate and allows to reduce the difference between biomechanical parameters of injured and sound legs to a minimum. After 30 lessons the difference of all parameters was lower in the experimental group of athletes on 5-7% than in the control one. Rehabilitation period of the MSS movement functions was reduced to 10-15 lessons in the experimental group as compared with the control group (Tab.1).

Results of the strength training test proved the efficiency of the elaborated methods - the difference in relative strength of muscles in sound and injured legs decreased significantly in the experimental group. The difference came to approximately 5-17% depending on the group of muscles.

Experimental data provided the opportunity to reveal the rehabilitation peculiarities of motor functions in top and non-top runners with the same injury localization at the knee joint. It was found that rehabilitation of functions is more intensive with top athletes. Rehabilitation periods turned out to be less than approximately 10-20 lessons. That was also proved by the test results of the lower limbs muscles strength training.

TABLE 1
CHANGE OF INTENSITY, LOAD VOLUME AND MOVEMENT PARAMETERS DURING THE EXPERIMENT

N/N of lessons	Conditions and means of training	Control group	Experimental group
1	2	3	4
1-5	GPT (min)	8-10	8-10
	SPT (min)	-	-
	PGL (%)	-	30
	EMS (min)	-	3-5
	V (m/sec)	3	3
	T (min)	5-10	5-10
5-10	GPT (min)	10-15	10-15
	SPT (min)	-	3-5
	PGL (%)	-	20
	EMS (min)	-	5
	V (m/sec)	3	3
	T (min)	10-15	10-15
10-15	GPT (min)	10-15	10-15
	SPT (min)	3-5	10-15
	PGL (%)	-	15
	EMS (min)	-	5
	V (m/sec)	3	3-4
	T (min)	20-25	25-30
15-20	GPT (min)	10-15	10-15
	SPT (min)	5-10	15-20
	PGL (%)	-	10-15
	EMS (min)	-	5
	V (m/sec)	3	3-4
	T (min)	25-30	30-35
20-25	GPT (min)	10-15	10-15
	SPT (min)	10-15	15-20
	PGL (%)	-	10
	EMS (min)	-	3-5
	V (m/sec)	3-4	3-5
	T (min)	30-35	40-45

TABLE 1 (continued)

25-30	GPT (min)	15-20	15-20
	SPT (min)	15-20	15-20
	FGL (%)	-	10
	EMS (min)	-	3
	V (m/sec)	3-5	3-5
	T (min)	40-50	50-60

GPT (min) - general physical training;
SPT (min) - special physical training (reduction percentage is the same as with FGL);
FGL (%) - force gravity limitation percentage (from athlete's weight);
EMS (min) - electromyostimulation signal duration;
V (m/sec) - velocity
T (min) - time of running

The experiment also revealed the difference in the rehabilitation character in different injury localization. The athletes after knee injury went through rehabilitation periods faster: the same level of function rehabilitation was achieved 5-10 lessons earlier and movement differences of sound and injured legs by the 30th lesson was on 4-6% lower than with the runners who had ankle injuries formerly. After the experiment the difference in the level of injured and sound legs relative muscle stength was approximately 7-12% in the group with functional knee disorders.

DISCUSSION

The decrease of functional potentials of the trained limbs leads in running to the changes of movement structure. The capacity of motor-support system for absorption of shock loads decreases which is significantly compensated by excessive joint flexion in the support period. This results in more intensive vertical oscillations of the body and is energetically unreasonable. The increase of total electrical muscle activity of an injured leg and limitation of movement range are a kind of prevention mechanism from further injuries. Decrease of ankle and foot muscle-extensors functional capacities which perform one of the main functions in the support period, apparently is the reason for the indicated changes in the movements of the injured legs.

Rehabilitation intensification after knee and ankle joints injuries were determined by creation of comfortable conditions in the process of running which provided shock load decreases on lower limbs and economic muscle work. Electric stimulation of m. gastrocnemius fixed the extremity position at the moment of its contact with support which lessened joint flexion, vertical oscillations and provided for better absorption of shock. Movement control in running improved intermuscular coordination and decreased the difference of strength capacity of injured and sound legs.

CONCLUSIONS

It is possible to note the perspective use of elaborated methods for the discovery of "weak" movement joints, prevention of injuries, running technique instruction again is aimed at injury stability and for effective MSS functions' rehabilitation after traumas and illness.

In my opinion the efficiency of these means is determined by the use of training devices, with instant information that allows one to redistribute physical load, to decrease its local activity on the "weak" movement joint and increase general influences. It gives opportunity "to unload" significantly the injured limb and to train in rather strenuous conditions to quicken rehabilitation.

It is impossible to understate the use of electrostimulation -except artificial "strengthening of weak" movement limb - this method also has a purely medical effect. The most significant effect was obtained when FGL method was combined with means of urgent information as a method of "redistributing" the loading of a sportsmen and reducing the local influence on the injured limb, with electrostimulation as "an amplifier" of the injured extremity and peculiar treatment method. All this in combination with sport training principles led to an elaboration of rather effective methods of correction and movement formation after MSS injuries of an athlete, which may be regarded as one of the worth-while theories and methods of movement formation as a factor of stable performance in sports.

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