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Optimization technologies of spine muscular-ligamentous apparatus functional state in young athletes, who go in for jiu-jitsu

Filipp Yu. Pitirkin, Olga I. Kolomiets*, Nadezhda P. Petrushkina, Elena A. Sazanova

Ural State University of Physical Culture
Chelyabinsk, Russia

ORCID: 0000-0002-4744-2135, fil5_888@mail.ru

ORCID: 0000-0003-4623-856X, Kolomiec_o@mail.ru*

ORCID: 0000-0002-0830-0206, 25ppnn@mail.ru

ORCID: 0000-0002-2802-3285, sazonovae@yandex.ru

Abstract: The specificity of training and competitive process in Jiu-jitsu is unfavorable influence of power oriented and impact loads on different elements of spinal column. In this connection athletes are always in danger of constant injuries. High level of spine muscular-ligamentous apparatus morpho-functional state is one of the preventive means of sports traumatism.

Materials. For the procedures effectiveness estimation, directed toward functional state of spine muscular-ligamentous apparatus optimization, we examined 136 people (the average age $13,5 \pm 2,41$): 68 of them went in for general physical training and 68 people went in for Jiu-jitsu during 3-5 years. **Research methods.** Information sources analysis and summarizing, methods of mathematical statistics, an interference (surface) method of electromyography: simultaneous study of paravertebral muscles strength in 3 sections (cervical, thoracic, lumbar) on the right (D) and left (L) sides, at rest and tension. **Results.** At the 1st stage according to the signs of spine muscular-ligamentous apparatus dysfunction in young athletes, who go in for Ju-jitsu, we revealed a risk injuries group according to the following characteristics: distinct «at rest» biopotential asymmetry, «in tension» biopotential of muscles change less than for 300 $\mu\text{m/V}$, insufficient relaxation «at rest» or «hypersynchronization» during tension (muscles dystonia). At the 2nd stage of the research we formed two groups of athletes. For them according to electromyography results the risk of injuries was the highest. Athletes in the group (Corden+progressive reflexotherapy) (n=30) performed the exercises at «Corden» training simulator and progressive reflexology at «Redox» applicator (30 minutes a day - independently). In (Remedial gymnastics+Massage) group (n=30), the masseur and the instructor performed collar zone massage and physical therapy. At the end of the experiment we registered the signs of muscle tone improvement in paravertebral muscles in all parts of the vertebral column in both groups. There were statistically valid changes in the group. They used the complex of exercises at Corden training simulators and progressive reflexotherapy. **Conclusion.** The results of the research helped to recommend the complex of exercises at Corden training simulator and reflexotherapy for cervical part of spine injuries prevention in young athletes, who go in for Jiu-jitsu.

Keywords: athletes, Ju-jitsu, muscle tone, electromyography, «Corden» training simulator, progressive reflexotherapy.

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INTRODUCTION

According to statistical results [1, 2, 3, 4] of general amount of injuries in terms of 1000 athletes single combats take the third place after rugby and hockey (5,2 cases among 1000 athletes). During the frequency of injuries calculation in terms of 1000 competitions, wrestling also takes the 1st four places of the highest injury factor, 26,4 cases (hockey - 16,3

cases, football – 18,8 cases, American football – 36,9 cases).

In single combats the most frequently injured part is spine. Injuries of cervical part of spine form 70% of all injuries among wrestlers. The most frequent and the most dangerous result of such kind of injuries is cerebral blood flow violation. It can appear even later [6] and lead to disability of

wrestlers and the end of their sports career.

In terms of biomechanics cervical part of spine injuries are connected with vertical mechanism of damage and are conditioned by “functional position of spine in neutral position and the power of support reaction influence. It is directed toward the spinal axis” [14]. Sports traumatism is a controlled process. It is considered that in terms of necessary preventive measures sports injuries can be minimal. Among the main reasons for sports injuries are the following: not correct lessons organization; mistakes in the methodology of lessons organization; not satisfactory state of the lessons places organization and sports equipment and others [5].

Also important factors of traumatism prevention are physical and psychic readiness and morpho-functional peculiarities of athletes. We take into account the fact that the specificity of training and competitive process in Jiu-jitsu is unfavorable influence of power oriented and impact loads on different elements of spinal column, it is necessary to strengthen spine muscular-ligamentous apparatus while mastering the technique of wrestling. The search for the methods of the functional state optimization of spine muscular-ligamentous apparatus in young athletes still continues. Thus, this research is very urgent.

The mechanism of the progressive reflexotherapy (PR) influence at “Redox” applicator (stainless steel with zinc and silver spraying) with the slope angle of needles 45 is in multi factorial interaction between regulatory mechanisms, reserve capacities of the functional systems activation. They control metabolic reactions [8].

One of the innovative methods of the influence on the spine is Corden apparatus use. It is widely used in medicine for different disorders treatment: osteochondrosis and bearing disorders, hernia of intervertebral discs and others. Exercises at “Corden” are fulfilled for chronic muscle over-tension and biomechanical disorders of locomotor system avoidance. They are caused by the training loads [10,11,12].

Physiological mechanisms of the apparatus remedial effect scientists connect with kinesthetic receptors, deep muscle groups of spine, fascia, spine muscular-ligamentous apparatus irritation,

shortened muscles stretching. Arc-like joints opening helps to renew their flexibility. It is obvious, that “Corden” apparatus use in the group of athletes, who go in for single combats, can provide spine strengthening and become one of the leading means in the system of traumatism prevention [10,11].

The aim of the present research work was to estimate the effectiveness of rehabilitation programs. They include “Corden” apparatus use, according to the indices of the functional state of spine muscular-ligamentous apparatus in young athletes, who go in for Jiu-jitsu.

MATERIALS AND METHODS

The research was held at sports medicine and physical rehabilitation department (Ural State University of Physical Culture, Chelyabinsk) in terms of state task fulfillment for the applied scientific research works organization in the sphere of physical culture and sport (order of the Ministry of sport of the Russian Federation, December, 20, 2019, № 1080). We examined 136 athletes at the age of 10-16 (the average age $13,75 \pm 2,39$): 68 boys, who went in for general physical training (GPT group) and 68 athletes, who went in for Jiu-jitsu during 3-5 years (JJ group). We received the permission of Ethical Committee for the research organization and the agreement of the experiment participants and their parents [7].

In order to estimate the functional state of spine muscular-ligamentous apparatus in the participants of the experiment we organized electromyography with muscles biopotential registration at “Neuromian” apparatus (model 401, “Medikom”, Russia). We used noninvasive interference (surface) method of electromyography. We studied simultaneously the power of muscles on the right (D) and left (L) sides in 3 sections: cervical (C), thoracic (Th), lumbar (L). We received the indices of electromyography at rest (norm – less than 100 $\mu\text{m/V}$) and tension (normal range – 300 till 1500 $\mu\text{m/V}$) [13].

At the 1st stage we compared electromyography indices in GPT and JJ groups. Muscle tone change less than 300 $\mu\text{m/V}$, distinct muscles asymmetry at rest, and muscle tone dystonia (insufficient relaxation at rest and

hypersynchronization during tension) prove high risk of injuries [13].

At the 2nd stage of the research we formed two groups of athletes, who, according to electromyography indices, had the highest risk of getting injuries. The athletes from (Corden+RT) group (n=30) fulfilled the exercises at "Corden" training simulator and progressive reflexotherapy at "Redox" applicator (after training the methodology and then 30 minutes a day independently). In another group (n=30) the massage therapist and the instructor fulfilled collar zone and Remedial gymnastics (RG+M) (30 minutes every day).

The effectiveness of the used technologies estimation was realized according to the dynamics of electromyography indices change. The received results were handled with the help of traditional biostatistics methods. We calculated the mean values (M), the mistakes of the mean (m) and standard deviations (σ). Then for the validity of differences estimation we used Student t-test (quantitative marks) and Fisher's ratio test (qualitative characteristics) [9]. The differences between the groups were considered statistically valid in case $t \geq 1,96$ and in case $F \geq 4,098$. We accepted 95% level of validity.

RESULTS AND DISCUSSION

The received results are reflected in tables. Table 1 shows that the mean values of muscle tone indices at rest in JJ and in GPT groups didn't differ.

According to the results of the initial study at tension young athletes from both groups were divided into subgroups: with normal muscle tone, with hypersthenia and hypotonia. In both groups we calculated the mean values of muscle tone in the revealed groups of young athletes, who go in for Jiu-jitsu and GPT, at tension (table 2). We revealed no valid differences. These results and the fact that at tension the frequency of deviations from normal values at tension also had similarity both in JJ group and GPT group (table 3), prove their wide popularity in children both athletes and "non-athletes". It is obvious that in this research work muscle imbalance is the problem of growth and age related peculiarity, but can be also connected with some other reasons, including wrong and irrational motor regimen,

long-term sitting position (at a table, working with computer) and others.

The results of electromyography in JJ group prove sufficient, but asymmetric development of thoracic section muscles random effort (Th): from $46,5 \pm 7,16$ till $289,9 \pm 43,92$ – from the right and from $45,2 \pm 3,96$ till $345,2 \pm 41,64$ – from the left. In lumbar section (L) there was sufficient and symmetric development of muscles random efforts: from $70,1 \pm 4,34$ till $524,7 \pm 33,45$, from the left – from $70,6 \pm 3,97$ till $580,5 \pm 18,22$, more than $300 \mu\text{m/V}$. At the same time in cervical section we revealed asynchronous amplitude of power (from $97,6 \pm 5,85$ till $320,4 \pm 89,97$ – from the right and from $99,6 \pm 4,89$ till $343,4 \pm 88,86$ – from the left), which proves insufficient development of muscles random efforts at lumbar cord ($< 300 \mu\text{m/V}$).

As it was mentioned above, hypersthenia and hypotonia of spine muscles at tension, distinct asymmetry of muscles at rest and muscles dystonia (insufficient relaxation at rest and insufficient development of random strengthening muscles) prove high risk of traumatism. Taking this into consideration in order to realize the 2nd stage of the research athletes with hypertonic and hypotonic reactions for tension (60 people) were chosen for rehabilitation means testing. With the help of random sampling we formed two groups of athletes (30 people each). In the 1st group RG complex and massage (RG+M) were held. The athletes from the second group were taught the exercises at "Corden" training simulator and in addition reflexotherapy was used (Corden+RT).

The dynamics of myography results at the end of the rehabilitation program is presented by tables 4-5. They show that before the rehabilitation there were no statistically valid differences between the groups ($p > 0,05$). However, after the initial electromyography of cervical part and lumbar cord analysis we registered asymmetry of the amplitude characteristics both at rest and after tension, at the same time, muscle tension was more distinct on the right side.

In general both groups had valid muscle tone improvement in all parts of the spinal column. However, in Corden+RT group the dynamics turned out to be more distinct (differences valid), which

proves more effectiveness of the complex of exercises at “Corden” training simulator and reflexotherapy.

Biopotential of the muscles at rest among the athletes, who go in for Jiu-jitsu, before the rehabilitation was within the following range: from 40 till 99 $\mu\text{m}/\text{V}$. It should be noted that we didn't reveal any pathologies in different parts of the spine. After the course of rehabilitation in Corden+RT group the indices of muscle tension at rest decreased till 34,8-82 $\mu\text{m}/\text{V}$. The indices of interference surface of electromyography (table 4) in both groups corresponded with the deep amplitude – more than 300 $\mu\text{m}/\text{V}$.

In general there was valid muscle tone improvement in both groups in all parts of the spine, however, in Corden+RT group the dynamics turned out to be more distinct. It proves greater effectiveness of the complex of exercises at “Corden” training simulator and reflexotherapy.

The specificity of “Corden” training simulator influence is in the fact that it affects paravertebral deep muscles (long spine extensor, segment spine muscle, intervertebral muscles). They are deep and don't relax during the massage. The repeated relaxation of paravertebral muscles under the influence of this procedure gives them normal muscle tone and there is muscle blockade of the disks ease, the flexibility of spine rehabilitation and etc.. It is obvious that such changes provide the risk of injuries decrease.

The research continuation provides detailed analysis of traumatism (during the preparatory and competitive period) in the groups of athletes, who go in for Jiu-jitsu, among whom we use different procedures, directed toward the functional state of spine improvement.

Conclusion

The results of interference (surface) electromyography, held at rest and during spine muscles tension after the course of trainings at “Corden” training simulator, proved positive influence on the functional state of spine muscular-ligamentous apparatus in young athletes, who go in for jiu-jitsu. Trainings at “Corden” training simulator in combination with progressive reflexotherapy statistically improve tonic qualities

of muscle at cervical, thoracic, lumbar parts of the spine. In general these training lessons have more distinct positive influence, than traditional methods of physical rehabilitation (massage and RG). In this connection “Corden” training simulator in combination with progressive reflexotherapy can be recommended for injuries prevention in cervical part of the spine in young athletes. They go in for single combats. It is obvious that in case of a long-term use of this technology significant results can be achieved without the help of massage and RG specialists.

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Table 1 – The mean values of muscle tone among young athletes, who go in for Jiu-jitsu and GPT at rest ($\mu\text{m/V}$)

The part of the spine	Side	Groups, the number of the respondents, M – mean values ($\mu\text{m/V}$) $\pm$ m – mean mistake, validity level of the differences					
		JJ group n=68		GPT group n=68		p*	
		M	$\pm$ m	M	$\pm$ m		
C	D	90,6	5,85	94,1	5,93	>0,05	
	S	99,6	4,89	98,7	4,46	>0,05	
Th	D	46,5	7,16	40,5	4,65	>0,05	
	S	45,2	3,96	44,5	3,76	>0,05	
L	D	70,1	4,34	65,5	5,24	>0,05	
	S	78,6	3,97	64,9	5,14	>0,05	

* - valid differences between the groups in terms $p < 0,05$

Table 2 – The mean values of muscle tone among young athletes, who go in for Jiu-jitsu and GPT at tension ($\mu\text{m/V}$)

The part of the spine	Muscle tone estimation	Groups, the number of the respondents, M – mean values ($\mu\text{m/V}$) $\pm$ m – mean mistake, validity level of the differences					
		JJ group n=68		GPT group n=68		p*	
		M	$\pm$ m	M	$\pm$ m		
C	norm	368,4	7,71	350,4	3,42	>0,05	
	hypertonia	1590,4	5,82	1600,4	6,71	>0,05	
	hypotonia	203,6	5,31	220,4	3,93	>0,05	

Th	norm	310,3	0,82	309,4	2,14	>0,05
	hypertonia	1530,1	4,12	1510,8	3,32	>0,05
	hypotonia	290,6	2,01	289,3	4,01	>0,05
L	norm	340,0	6,43	349,4	0,63	>0,05
	hypertonia	1533,2	3,31	1594,1	7,81	>0,05
	hypotonia	280,4	3,91	272,3	4,41	>0,05

* - valid differences between the groups in terms $p < 0,05$

Table 3 – Distribution of young athletes, who go in for Jiu-jitsu and GPT, according to muscle tone estimation at tension (abs. / %)

The part of the spine	Muscle tone estimation	Groups, the number of the respondents, abs. number, percentage, validity level of the differences				
		JJ group n=68		GPT group n=68		p*
		abs.	%	abs.	%	
C	norm	8	11,8	6	8,8	>0,05
	hypertonia	22	32,3	30	29,4	>0,05
	hypotonia	38	55,9	42	61,8	>0,05
Th	norm	8	11,8	6	8,8	>0,05
	hypertonia	22	32,3	30	29,4	>0,05
	hypotonia	38	55,9	42	61,8	>0,05
L	norm	8	11,8	6	8,8	>0,05
	hypertonia	22	32,3	30	29,4	>0,05
	hypotonia	38	55,9	42	61,8	>0,05

* - valid differences between the groups in terms $p < 0,05$

Table 4 – Dynamics of mean values of muscle tone at rest among young athletes with different rehabilitation programs, ($\mu\text{m}/\text{V}$)

The part of the spine	Side	Groups, the number of the respondents, M – mean values (μm/V) ± m – mean mistake, validity level of the differences				p*
		RG+M group n=30		Corden+RT group n=30		
		before 1	after 2	Before 3	After 4	
C	D	93,3±3,32	66,6±8,23	99,3±0,14	55,0±4,01	$p_{2-4} < 0,05$
	S	94,2±2,91	60,3±3,41	96,4±2,13	50,8±2,32	$p_{2-4} < 0,05$
Th	D	46,3±7,82	40,3±4,13	48,5±1,21	30,4±0,91	$p_{2-4} < 0,05$
	S	49,2±3,32	45,6±4,02	46,3±2,44	42,3±0,82	
L	D	70,9±1,13	59,8±0,11	69,9±2,12	36,4±8,04	$p_{2-4} < 0,05$
	S	72,3±3,97	56,4±0,34	73,8±3,43	40,3±0,91	$p_{2-4} < 0,05$

* - valid differences between the groups in terms $p < 0,05$

Table 5 – Dynamics of mean values of muscle tone at tension among young athletes with different rehabilitation programs, ($\mu\text{m}/\text{V}$)

The part of the spine	Side	Groups, the number of the respondents, M – mean values ($\mu\text{m}/\text{V}$) $\pm$ m – mean mistake, validity level of the differences				p*
		RG+M group n=30		Corden+RT group n=30		
		before	after	before	after	
		1	2	3	4	
C	D	1593,3 $\pm$ 3,41	1203,4 $\pm$ 1,13	1601,4 $\pm$ 0,91	1101,4 $\pm$ 3,04	p_{2-4} <0,05
	S	208,3 $\pm$ 5,62	364,2 $\pm$ 2,24	230,4 $\pm$ 3,12	409,9 $\pm$ 5,41	p_{2-4} <0,05
Th	D	1523,4 $\pm$ 2,13	1404,3 $\pm$ 7,81	1515,9 $\pm$ 3,13	1204,3 $\pm$ 1,13	p_{2-4} <0,05
	S	284,0 $\pm$ 3,32	300,4 $\pm$ 2,12	287,0 $\pm$ 0,91	390,1 $\pm$ 0,92	p_{2-4} <0,05
L	D	1591,4 $\pm$ 2,24	1223,4 $\pm$ 0,91	1590,0 $\pm$ 1,03	1150,2 $\pm$ 2,21	p_{2-4} <0,05
	S	209,1 $\pm$ 0,34	390,1 $\pm$ 3,14	273,2 $\pm$ 4,15	415,4 $\pm$ 1,32	p_{2-4} <0,05

* - valid differences between the groups in terms $p < 0,05$

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Author's information:

Filipp Yu. Pitirkin – Post-graduate, Ural State University of Physical Culture, 454091, Russia, Chelyabinsk, Ordzhonikidze str., House 1, e-mail: fil5_888@mail.ru

Olga I. Kolomiets – Candidate of Biological Sciences, Associate Professor, Ural State University of Physical Culture, 454091, Russia, Chelyabinsk, Ordzhonikidze str., House 1, e-mail: Kolomiec_o@mail.ru

Nadezhda P. Petrushkina – Doctor of Medical Sciences, Senior Research Scientist, Ural State University of Physical Culture, 454091, Russia, Chelyabinsk, Ordzhonikidze str., House 1, e-mail: 25ppnn@mail.ru

Elena A. Sazonova – Candidate of Medical Sciences, Associate Professor; Ural State University of Physical Culture, 454091, Russia, Chelyabinsk, Ordzhonikidze str., House 1, e-mail: sazonovae@yandex.ru