Journal of Physical Education and Sport ® (JPES),Vol 21 (Suppl. issue 5), Art 397 pp 2987 – 2992, Oct 2021
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Specific rehabilitation characteristics of myofascial pain syndromes in athletes (acyclic sports)

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Published online: October 30, 2021
(Accepted for publication October 15, 2021)
DOI:10.7752/jpes.2021.s5397

Abstract:
The progress of myofascial syndrome is specific for sports activities and unavoidably occurs with increase of intensity and length of training and competition loads. Typical myofascial dysfunction manifestation includes a muscle spasm, painful muscle indurations in a toughened muscle, reduced muscle elasticity, as well as reduced speed, strength and coordination of movement, being important aspects for sports activities. The aim of this study was substantiation and experimental approbation of the program for myofascial pain syndromes correction in athletes in sports activities-related conditions. The participants of this study were 28 young men at the age 18-20 years old specializing in single combat, who were divided into two groups: the main and the control one. Duration of the study: 6 months. In the main group, apart from stretching of muscles with the signs of myofascial dysfunction, we used trigger points post-isometric relaxation and ischemic compression techniques. To verify the findings obtained we performed muscle electromyography. The athletes' functional fitness was evaluated based on visual-motor response. A control study at the end of the application of rehabilitation measures revealed a significant decrease in the bioelectrical activity of muscles with signs of myofascial dysfunction. The findings show that combined application of the proposed soft manual techniques is a low-priced and available instrument, which requires no special medical equipment and allows correcting myofascial dysfunction manifestations in training activities-related conditions. Such approach as a whole contributes to preserving the athlete's performance capability and reduces the necessity to perform separate rehabilitation cycles out-of-training activity. Negative impact of myofascial dysfunction on athlete's psychophysiological sphere requires additional corrective measures for higher nervous system levels within rehabilitation programs.
Key words*:* **trigger points post-isometric relaxation technique, ischemic compression.**

Introduction

Introduction should be comprehensible to the general reader. Give a clear statement of the purpose of the paper and provide relevant context to support the basis for the paper and the significance of the work. Do not exhaustively review the literature. Heavy physical and psychic loads in modern sports, without which it would be impossible to reach high achievements in sports, on frequent occasions cause overstrain of different systems of athlete's body. Early sports-related specialization, sophisticated movement elements technique, failure of sufficient rehabilitation measures during training and competition periods contribute to formation of pathological changes in locomotor apparatus (Hidalgo-Lozano et al., 2013; Kashuba et al., 2020). Myofascial pain syndrome, reducing functional readiness, causing damage to performance capability and deteriorating athletes' health, is one of such negative manifestations (MPS) (Hagg, 2000; Osborne et al., 2010; Dido et al., 2021).

Myofascial pain syndrome manifests itself as a muscle spasm, painful muscle indurations in a toughened muscle as well as reduced muscle elasticity, reduced speed, strength and coordination of movement, being very important aspects for sports activities (Kao et al., 2007; Skarabot et al., 2015). The works of Travell J. i Simons D constitute fundamental studies related to MPS. They presuppose that muscular dysfunction forms the basis for MPS formation, and those areas of focal muscle indurations – "myofascial trigger points" in a painful muscle are formed additionally against the background of long existing functional disturbances (Simons et al., 1999; Simons, 2004). As part of the further studies, typical myofascial syndrome diagnostic criteria were proposed (Simons, 2004; Simons, 2008):

1." Large" criteria (presence of all five symptoms) – complaints including local or regional paints, restricted joint range of motions, indurations in an affected muscle, areas of hypersensibility within indurations (myofascial trigger point, MTP), heterotopic pain being typical for such affected muscle.

2. "Small" criteria (presence of one of three symptoms): appearance of pain while stimulating trigger points, affected muscle shudder at palpation, pain decreasing at stretching of affected muscle.

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Myotasis and muscle strain against the background of physical activity, at durable repeated monotonous physical activity, local traumas, occupational muscular micro-traumatism, muscle strain at different lower extremities lengths, prevailing extremities movements resulting from exercise load nature or psychologic stress are considered as primary etiological agents (Hong, 2008; Gerwin, 2010).

For athlete's myofascial dysfunction (MD) pathologic behavior, a residual tonic muscle strength after work performance is of primary importance, which rate depends not merely on the nature, intensity and scope of physical load, but also on peculiarities of individual functioning of different sections of the central nervous system performing organization of motor and sensor movement acts as well as vegetative and emotional activities (Lucas, 2008). Acute or chronical stress loads inherent to athletes increase the stress hormones production and activate the sympathetic nervous system (Kostopoulos et al., 2008). It is considered that the increase of hormones level and sympathetic stimulation in such state contribute to the increased acetylcholine production in nerve muscle joints thus resulting in motor units contraction causing the increased trigger point irritability (Hocking, 2010).

In any case, a leading pathogenic mechanism for formation of myofascial dysfunction is a long-lasting reflection myotony in a restricted area with the further activation of central nociceptive structures (Morozova et al., 2009; Ivanichev, 2019). Due to afferent stream amplification and neuronal excitation in different sections of the central nervous system, in course of time a primary area of pain sensitivity can spread and go beyond the affected muscles at a later stage (MacDonald et al., 2013). The area of secondary hyperalgesia may be located wide enough from an affected place, including the muscles of the opposite side. The primary peripheral injury triggers a cascade of pathophysiological processes, which in course of time involves the whole nociceptive system - from tissue receptors to cortical neurons (Ge et al., 2011; Beardsley et al., 2015).

So, the impact on the athlete's psychophysiological sphere realizing his/her aimed movement acts constitutes a crucial aspect of myofascial dysfunction generalization. Adequate psychophysiological responses are the background for successful performance of complex movement programs in sports and vice versa disorganization of this system regulation level worsens sports achievements, enhances inadequate motor reflexes thus causing MFPS progressing. And the further training process as well as participation in sporting events against the background of myofascial disorders serves as a risk factor for sports injury production, increases the time for recovery or forces an athlete to stop trainings for a long time so making it impossible for him/her to continue the competitive carrier (Bogdanovska et al., 2019). Therefore, the rehabilitation of athletes having myofascial pain syndrome should secure reparation of disease manifestations at short notice and shorten a long remission period.

The aim of this study was substantiation and experimental approbation of the program for myofascial pain syndromes correction in athletes in sports activities-related conditions.

Material & methods

Participants. The study was performed on basis of Zaporizhzhia Oblast Treatment and Fitness Health Center (Ukraine). The participants of the study were 28 young men at the age 18-20 years old specializing in single combat who complained of periodic pain sense modalities in dorsum muscles with permanent character which increased during trainings. Inclusion in the study program was based on the standardized selection criteria: 1) document of consent for participation in the study approved by the Ethics Committee signed by the research participants; 2) possibility and desire of the research participants to meet all the protocol requirements during the whole period of study program realization.

Goals, methods and procedures. In course of the clinical study, we defined that all participants suffered from pain of muscle etiology i.e. such pain was induced due to muscle tonic dysfunction. To exclude the secondary genesis of pain muscle syndrome all young men were examined using MRT examination of the respective dorsal spine segment. The participants were divided into two equal groups using technique of random sampling: the main and the control one. Each group consisted of 14 persons.

Bioelectric muscle activity was registered by means of skin bipolar electrodes using 'Synapsis' electromyography sensor ("Dx-systems", Ukraine). We measured the amplitude of interference electromyogram of the superior and the inferior portion of m. trapezius, m. sternocleidomastoideus and m. gluteus maximus. Psychophysiological and electromyographic indices of 20 healthy research participants at the age of 18-20 years old were used as control means. To evaluate impact of myofascial dysfunction on athletes' functional readiness we performed a psychophysiological investigation using 'HC-psychotest' computer complex ("Spectromed", Ukraine) with determining the time of simple and complex visual-motor response to photic stimulus. Research participants had as soon as possible to push the button in response to optical signal (signal combination) to be set randomly in certain time intervals. We evaluated intervals between a signal and the start of response considered as response time. The lower values of this index give evidence of the higher level of sensor-motor sphere functional possibilities, reactivity and excitability of athlete's central nervous system.

The rehabilitation program for athletes of both groups included local application of non- steroid antiphlogistic agents and therapeutic exercises for muscle stretching activated during training sessions (for separate muscles after each change of load and for all muscles after training). Stretching duration was dosed by holding a certain body position for a certain time (10-20 seconds). For the athletes of the main group the daily sessions of post-isometric muscle relaxation were held (Vernon et al., 2009), in addition to trigger points ischemic compression technique (Fernandez-de-las-Penas et al., 2006; Wang et al., 2010).

Post-isometric muscle relaxation technique is based on combination of short-term isometric muscle strength with the following passive muscle stretching (Bron et al., 2011). As a result of cyclic performance of the above actions, the muscle relaxes and its painfulness decreases. Isometric load per muscle made 5-7 isometric exercises within 7 seconds with the following passive muscle stretching within the same time period. Isometric muscle contraction was performed with maximum muscular effort (Hanten et al., 2000; Kannan, 2012). The athletes' performance has been monitored during 6 months. The rehabilitation program was realized on an in-service training sessions basis.

Statistical analysis. Statistical processing of the results obtained was carried out based on Statistica 6.0 software package. For evaluation of significance of intergroup diversities Mann-Whitney-Wilcoxon criteria were applied. Spearman's rank correlation coefficient technique was used to summarize a relationship and strength of a relationship between two variables. The diversity was always considered statistically significant with $p<0.05$.

Results

During the initial clinical study, the athletes of both groups featured active and latent myofascial trigger points which constitute a neurophysiological basis of myofascial syndrome, so we defined typical MTP localization variants in single combat athletes. The data of electromyographic research of muscles with the signs of myofascial dysfunction are shown in Table 1.

Table 1 – Amplitude measures of bioelectric muscle activity at rest in athletes with myofascial syndrome at the beginning and at the end of the study (X±m, uV)

Muscle	CG (n=14)		MG (n=14)		Comparison group (n=20)
	at the beginning	at the end	at the beginning	at the end	
m. sternocleidomastoideus	55.78±3.12	49.72±3.11	54.5±4.23	40.51±2.02*	34.53±3.10
Superior portion of m. trapezius	68.15±3.23	60.12±5.42	65.78±3.14	46.14±3.14*	40.25±5.32
Inferior portion of m. trapezius	65.14±2.28	57.13±5.31	67.54±4.61	44.23±2.26*	36.18±2.42
m. gluteus maximus	39.96±4.31	35.86±2.23	38.18±3.26	30.14±1.25*	29.81±2.33

Note: * The differences between the study likely ($p<0.05$) in all parameters to the main group; here the data for the participants with max. clinical signs of myofascial syndrome are shown.

The above data demonstrate that during the initial clinical study we defined an increasing of muscle bioelectrical activity at rest in the athletes of both groups as compared to the athletes group without any signs of myofascial dysfunction. The diversity between the groups proved to be insignificant acc. to all researched factors. After two months of rehabilitation program application, we evidenced positive dynamics that manifested itself as reduced bioelectric activity of muscles with the signs of myofascial dysfunction at rest in the athletes of both groups. Thus, an average amplitude of bioelectric activity of m. trapezius superior portion of the athletes of the main group reduced from 54.45±4.23 uV to 40.51±2.02 uV, m. sternocleidomastoideus – from 54.45±4.23 uV to 40.51±2.02 uV, m. gluteus maximus – from 38.18±3.26 uV to 30.14±1.25 uV. The researched factors of the athletes of the control group showing positive dynamics remain significantly higher as compared to those of the control group ($p< 0.05$). Table 2 shows neurodynamic functions factors according to the results of sensor-motor activity whereby stimulants have been differentiated according to their complexity.

Table 2 – Neurodynamic functions factors of the athletes with myofascial syndrome at the beginning and at the end of the research

Factor	CG (n=14)		MG (n=14)		Comparison group (n=20)
	at the beginning	at the end	at the beginning	at the end	
Latent period of simple visual-motor response, ms	251.43±4.80	246.01±4.08	256.95±5.23	234.20±3.52*	234.81±4.24
Latent period of complex visual-motor response, ms					
1 – signal design of 1 of 3 signals	369.92±5.11	354.88±3.34	378.43±4.80	346.36±3.57*	343.20±6.52
2 – signal design of 2 of 3 signals	430.06±6.35	420.51±4.09	435.15±6.18	406.18±4.01*	400.31±5.23
Strength of the nerve process, % errors	18.45±1.23	17.18±1.13	18.11±1.55	15.61±1.12*	15.12±2.14

Note: * Significant diversities as compared to the beginning of the study ($p<0.05$).

As is evident from the Table, at the beginning of the study, latent period of simple visual-motor response of the athletes of the main group – 256.95±5.23 ms is 9.42% significantly higher than that of practically healthy athletes 234.81±4.24 ms, at the significance level p<0.05. When studying latent period of complex visual-motor response, we established that the factor of signal design of 1 of 3 signals of the athletes MG – 378.43±4.80 ms was 10.26% significantly higher than that of the athletes of the comparison group – 343.20±6.52 ms, at the significance level p<0.05. The same factor of latent period of signal design of 2 of 3 signals of single combat athletes of the main group – 435.15±6.18 ms was 8.70% significantly higher than that of the athletes of the comparison group – 400.31±5.23 ms, at the significance level p<0.05. The athletes of the control group showed the similar results at the beginning of the study, whereby diversity with the main group was not significant.

As evidenced by the results of the control research conducted at the end of rehabilitation measures application, neurodynamic functions factors of the athletes of the main group showed statistically significant improvement as compared to the initial factor values: latent period of simple visual-motor response reduced up to 234.20±3.52 ms (p<0.05), latent period of complex visual-motor response with signal design of 1 of 3 signals reduced up to 346.36±3.57 ms (p<0.05), latent period of complex visual-motor response with signal design of 2 of 3 signals reduced up to 406.18±4.01ms (p<0.05). Strength of the nerve processes also showed statistically significant improvement: number of errors in the main group decreased from 18.11±1.55% up to 15.61±1.12% (p <0.05). The factors featuring the level of neurodynamic functions of the athletes of the main group improved as well, although, as compared with the beginning of the research, diversities were not significant.

Discussion

Single combat sports are acyclic sports requiring high-level maturity of speed-strength qualities and coordination. Motor stereotype in different combat types presupposes a complex coordination performance of the most muscle groups. Pathogenic action of throws on athletes' locomotor apparatus serves as a special condition related to such sports, and in the course of time, it results in excessive loading of spine locomotor apparatus, especially of cervical and lumbar spine. Weight exercises including barbell are of considerable current use during training sessions. As a part of the study, we defined that localization of myofascial trigger points was similar for representatives of different single combat sports and included mainly cervico-collar and lumbosacral variants. Typical muscles for formation of myofascial dysfunction in cervical spine include trapezius muscle, m. semispinalis and m. levator scapula; in lumbar spine - m. erector spinae and m. piriformis.

So, myofascial trigger points in single combat athletes settle mainly in the muscles, which directly perform special movement relevant to certain sports and in the muscles subjected to maximum static loads during performing sports exercises. We think that MD mechanism is specific for sports activities and inevitably occurs with increasing the intensity and period of training and competition loads. Dynamics of pain syndrome was closely associated with the nature of training and competition activities. Loads increasing and short period for muscle rehabilitation caused increased pains and on the contrary sufficient rest and application of rehabilitation measures contributed to pain regress.

The main task of elecrtomyographic research was to objectify the severity of myofascial manifestations in athletes. The study results showed that both the athletes of the main and of the control groups featured significant increase of bioelectric activity at rest in all researched muscle groups more pronounced in cervico-collar area as compared to the same factors in athletes having no signs of myofascial disorders. Thus, clinical myofascial pain syndrome manifestations are associated with the increased muscle activity at rest in the respective area. Active and latent trigger points serve as a source of massive proprioceptive sensory input in segmental structures of the central nervous system. It facilitates an increase of mononeuron tonic activity and results in the rise in muscle tonic stress. It means that the increased bioelectric muscle activity at rest, even failing trigger points, may characterize high probability of their occurrence in the respective muscle group.

The above results of psychophysiological research with definition of periods of simple and complex sensomotor reaction in athletes with MD manifestation evidence the availability of disorders in elementary central sensomotor mechanisms of motor performance. It can be preconditioned by disturbance of proprioceptive sensory input in the affected muscles, change in excitability and functional disintegration of higher centers of movements control and programming when affected by the abovementioned sensory input from myofascial TP. Therefore, frequent myofascial disorders are associated with psychophysiological sphere disturbance so affecting basic mechanism of voluntary movements control, and it can be a weighty factor that restricts successful sport activities.

Regardless of high rehabilitation results achieved, some athletes still have recurrences of myofascial dysfunction. Having analyzed the causes of exacerbation we determined that medical and pedagogical supervision was of significant importance for prevention of myofascial pain syndrome in athletes. First of all, it is important to use the data of athletes' current control and self-control during training and competition sessions in order to improve training techniques, detect the signs of myofascial pain syndrome at early stage and take additional measures for athletes rehabilitation in the course of training sessions.

Conclusions

Myofascial dysfunction is one of the most frequent pathological conditions of locomotor apparatus in sports, which adversely affects the functional performance of athletes even in absence of clinical complaints and increases risks of athletic injuries. Combined application of post-isometric muscle relaxation and trigger points ischemic compression technique is a low-priced and available instrument, which requires no special medical equipment and allows correlating myofascial dysfunction manifestations in training activity-related conditions. Generally, such approach contributes to preserving athletes' performance and to reducing the need to carry out rehabilitation cycles out-of-training activity. Although there is a very limited number of studies in regard to the effects of soft manual techniques on myofascial pain specifically for athletes. Whereas many specialists use this technique to treat different locomotor apparatus disorders, it is crucially important to perform qualitative clinical studies in order to evaluate effectiveness and efficiency of such measures for myofascial syndrome rehabilitation in athletes of different sport specializations.

The multifactor nature of MFPS dictates the need for complex use of rehabilitation measures with due account for leading mechanisms of pathological process, specifically the impact of MD on the athlete's psychophysiological sphere due to pathological sensory input from focuses in locomotor apparatus. So, myofascial dysfunction correction in athletes should not be merely limited to local action measures, but should also be directed at system mechanisms of pathological process including dysfunction of higher nervous system level.

Conflict of Interest. The authors declare that there is no conflict of interest that could be perceived as interfering with publication of the article.

Competing Interests. The authors declare that they have no competing interests.

Ethical Approval. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Funding sources. This study has not received any financial support from any government, community or commercial organization.

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