FEATURES INTERFERENCE EMG LEG EXTENSOR MUSCLES OF SKILLED PLAYERS IN THE CONTEXT OF THE SPECIAL EXERCISES

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Annotation. The article considers the problems of improvement of physical training of skilled players. The main instrumental method of the research is electromyography. The aim of the research is determination of the optimal angle of the provisions of legs on her hips for the appearance of a maximum of bioelectric activity of the muscles of the front panel hips in exercise unbending legs sitting on the mechanical simulator. In the course of research we have worked for electromyography 10 players of FC Metalist at the age of 19 – 30 years during the five-second of the submaximum contraction of these muscles as: musculus rectus femoris, musculus vastus medialis, musculus vastus lateralis. The results of the analysis of segments of electromyography allowed to make a conclusion, that we investigated the provisions of the angle of 140 degrees has the lowest preconditions for the appearance of muscle strength. We have obtained data testify to the fact that the angle of 90 degrees is the position of the greatest preconditions for the appearance of muscle strength.
Key words: electromyography, angle, force, application, mechanical, simulator, football, muscles, thigh.

Introduction

Modern football implies many sided by its forms and content technical movements, in which most of muscles of supporting motor system participate (V.V. Slomonko, G.A. Lisenchuk, 1996; V.N. Shamardin, 2004; Yu.D. Zheleznyak, Yu.M. Portnov, V.P. Savin, A.V. Leksakov, 2004). It is full of technical elements, in context of which muscles –extensors of shin constantly take part. It means not only counteraction to forces that influence on football player's body with jumping, running elements (force of gravity of own mass, responsive force of surface, resistance of air) but the influence of external bodies (foot contact with ball, struggle with adversary) (V.M. Khodukin, 1989; Yu.D. Zheleznyak, Yu.M. Portnov, V.P. Savin, A.V. Leksakov, 2004). In all these exercises muscles of supporting motor system always work as specialized system of single and successive movements, oriented on rational organization of interaction of external and internal forces. Now the task of first priority is to determine in which position in case "thigh is in relation to shin" muscles can manifest their maximal bio electrical activity and, according to researches by Gordon, Huxsley, Julian. (1966) [13], V.M. Zatsiorskiy [8] to exert maximal effort.

That is why in searching of new and improvement of already known systems of training process's organization first place is taken by automatic systems of measurements and processing of medical-biological information, which use up-to-date program means, substantially widening possibilities of differentiated estimation of load's localization on moving segment, which is under specific load [1, 3].

One of modern diagnostics methods is electric myography – method of nervous-muscular system's study with the help of registration of muscular's electric potentials. Electro-myographycal examinations permit not only to localize the area of accentuated influence on certain group of muscles, but also to objectively evaluate optimal angle of limb's location (in the case of our research – position of shin in relation to thigh), by determination of maximal bio electrical activity, position of maximal closing of actinomycotic filaments in sarcomere, in correspondence with applied force [5].

The basis of improvement of football players' physical conditions is highly effective organization of training process with aim to ensure adequacy of the used loads. Main methodic of electric myographic examinations includes analysis of interventional (surface, total) electric myograms, studying of T-reflexes, F-wave, H-reflex, M-response, etc. (B.M. Gekht, 1990; S.G. Nikolayev, 2003, 2010; L. Vovkanych, B. Vynogradskiy, V. Tkachek,) [6, 4, 10, 11].

Extension of shin in sitting position is caused by quadriceps muscle of thigh (Musculus quadriceps femoris) –which occupies all frontal and partially external part of thigh. It consists of: musculus rectus femoris (biarticulated muscle), musculus vastus medialis, musculus vastus lateralis, musculus vastus intermedius (monoarthric muscles) (F. Netter, 2003) [9]. Gordon, Huxsley, Julian (1966) [13] studied interconnection of force, which is manifested as contracting components and the length of muscle (in our case the less angle between shin and thigh is, the more muscle extends and vice versa) considering that force is the biggest in certain average length. It was established that during simultaneous registration of sarcomere's length, momentum force and closing of actinomycotic filaments in sarcomere, the force of contracting components is maximal with the fullest closing of this parts. Certain average length, in which contracting components of muscle can manifest the biggest force, is called the length of rest (V.M. Zatsiorskiy, 1981) [8]. With reducing or increasing of muscle's length the value of closing (and correspondingly the quantity of cross bridges reduces) the force weakens (V.F. Antonov, 2001) [2].

As on to-day the length of rest for shin's muscles-extensors has not been determined sufficiently in literature. Detail description of bio electrical activity of muscles of thigh's frontal group in structure of isometric contraction permits to determine optimal angle for manifestation of maximal force, to optimize the content of tactic & technical actions on the base of more efficient realization of special physical training.

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Purpose, tasks of the work, material and methods

The purpose of the research is determination of optimal angle of shin's position in relation to thigh for manifestation of maximal bio electrical activity of muscles of thigh's frontal group in exercise "extending of shin in sitting position" on mechanical simulator.

The methods and organization of the research. 10 players of main and backup staff of SC "Metalist" of 19-30 years old age participated in our research. The research was carried out at training base of SC "Metalist" in the first half of day with the help of computer electric neuro-myograph, production of scientific –production enterprise DX –Systems «M-TEST» that meets technical requirements ТУУ33.1-30428373-004-2004, and is designed for registration and analyzing of electric myograms (EMG). Electrodes Ag/AgCL Skintact easitabs RT34 with adhesive base were used. As per the data of S.G. Nikolayev (2003, 2010) [10, 11] we used electrodes with random inter-electrode distance: active electrode was fixed in innervations zone of appropriate muscle (over belly (along) of muscle, in projection of mobile zone), and reference electrode was fixed on a sinew or in the place of its fastening on bone's projection. The distance between proximal and distal electrodes is equal for every muscle.

It should be noted that with increasing of inter-electrode distance the amplitude of signal is also increases (S.G. Nikolayev 2003) [11]. The electrode-earth is located at distal part of opposite limb. It shall be connected with appropriate terminal on electrode panel of electric myograph. The circuit of this electrode closes capacity's difference of potentials between body of the tested and earth and facilitates elimination of capacity currents (S.G. Nikolayev, 2003) [11].

The research was fulfilled at mechanical simulator "extension of shin in sitting position", which permitted adjustment of angle of counteracting lever (reducing of shin's angle in relation to thigh) with right and left legs alternatively on the base of maximal weight under angles (see fig.1 – 140 degrees; fig.2 – 130 degrees; fig.3 – 120 degrees, fig.4- 105 degrees; fig.5 – 90 degrees; fig.6 – 80 degrees) that does not permit to move lever but stipulates application of force of the tested close to maximal. The angle of the applied force and the distance of counteracting lever are determined by construction of simulator and is standard for all the tested. Besides, adjusted back of simulator's seat (forward-backward in relation to the position of torso), depending on the length of thigh of the tested, permits to locate the axis of knee joint's rotation in one [7].

Determination of angle between thigh and shin was fulfilled with the help of photo-goniometric research. Point "0" of angle's change (axis of angle-meter's rotation) – is lateral projection of thigh bone; position of proximal axis (position of proximal branch of angle meter) – is big head of the femur; position of distal axis (position of angle meter's distal branch) – is lateral bone.

The following indicators were determined: maximal amplitude (mcV) – maximal amplitude, that is observed at given part of interferential myogram; mean amplitude (mcV) – mean amplitude of given part of analysis of interferential myogram; mean frequency – mean frequency of given part of analysis of interferential myogram; comparative coefficient – relation of mean amplitude to mean frequency of given part of analysis of interferential myogram.

For convenience of information's obtaining, the producer of electric neuro-myograph offered to introduce conventional difference of relations of mean amplitudes to mean frequencies between the compared channels. The close this indicator is to zero, the less asymmetry is observed between the compared channels.

In table the introduced mean indicator from ten studied ones, minimal and maximal indicators are considered as wrong and not suitable for system of calculation. In our research we set the speed of "tape" travelling within 200 mc.sec. p. cm, amplification (amplitude, that is reflected) of signal – 5 mcV.p. cm with current value of responses' quickness of 40 mc.p.cm., and current value of responses' amplification – 0.9 mV.p.cm. The obtained indicators were analyzed with the help of statistical methods and with program Microsoft Excel 2007.

Results of the researches

Just before examination we offered warming up on exercise bicycle with "vertical" seat during 8 minutes with gradual increasing of power and rotations per minute: 1-2 minutes – 60 r.p.m., - 40 W; 2-4 minutes – 70 r.p.m., - 80 W; 5-6 minutes – 80 r.p.m., - 120 W and then, with gradual reducing of the mentioned above indicators during 2 minutes and 5 minutes rest after it with execution of flexibility exercises.

In the process of our research we processed EMG of 10 tested during 5 minutes' manifestation of force, followed by 1-1.5 minutes' rest of such muscles as: musculus rectus femoris, musculus vastus medialis, musculus vastus lateralis. Electrodes (active and reference) were located in six symmetric points of left and right kegs at equal distance for every muscle. Locating electrodes it is necessary to consider possibility of bio electric signal's leakage – muscle cross-talk [13].

Projections of motor parts m. vastus medialis and m. vastus lateralis are located symmetrically on one leg, reference electrodes were fixed on proximal part of inside and outside parts of bone projection of kneecap; contraction function of m. rectus femoris, which has longer sinew section (in relation to m. vastus medialis and m. vastus lateralis) and is , in opposite to the above mentioned a biarticulated muscle, that conditions its contraction abilities' dependence on position of knee and ball joints (probably, the more thigh is bent and shin extended (proximal and distal parts of fixing are close to each other) or if thigh is extended and shin is bent (parts of fixing are distant) contraction ability is minimal).

We assume that motor section of m. rectus femoris is located in the area of middle one third of thigh (reference electrode was fastened on proximal part of its distal sinew section). Bio electric activity of m. vastus intermedius can not be studied with the help of surface electric myography owint to its anatomic location.

Let us consider possibility of this muscle electric signal's leakage in projection of m. rectus femoris's motor part. In tables and figures we presented the data, conditioned by final position. As it is seen in the figures, with changing of angle of shin's position in relation to thigh, mean and maximal amplitudes of interferential EMG also change, reaching their maximal value with right angle between shin and thigh. In this position mean frequency of oscillations was the least. This can witness that alpha-small motor-neurons were engaged in contraction, because they are highly sensitive, have low frequency of generated impulse with high level of endurance. With increasing of angle of moving segment's position in relation to thigh, mean frequency increases creating preconditions for involving of alpha large motor neurons, which are less sensitive and give higher impulses' frequency.


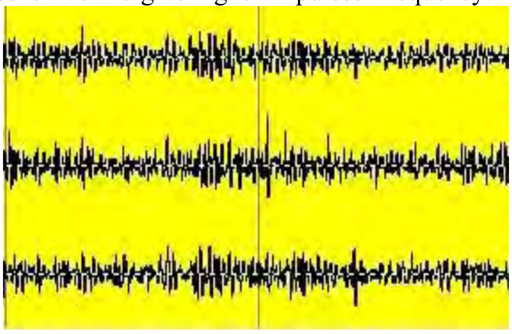

Fig. 1. Fragment of experiment Fig.1.1 Fragment of myogram

Table 1

Bio electrical activity of muscles with shin's position at 140 degrees angle

140 degrees	m. vastus medialis		m. rectus femoris		m. vastus lateralis	
	Right leg	Left leg	Right leg	Left leg	Right leg	Left leg
Maximal amplitude (mcV)	5926± 601. 4	5326± 587. 4	7021. 4± 731. 4	6895. 4± 701. 1	5781. 1± 489. 2	5232. 1± 508. 4
Mean amplitude (mcV)	996 7± 103. 2	830. 2± 92. 1	1127. 6± 124. 9	1084. 6± 108. 7	1120. 4± 87. 0	1031. 4± 73. 0
Mean frequency (Hz)	107. 7± 10. 1	95. 2± 8. 4	136. 3± 9. 8	121. 2± 7. 6	117. 1± 7. 7	103. 1± 8. 0
Comparative coefficient	9. 29± 0. 7	7. 35± 0. 8	8. 28± 0. 4	8. 05± 0. 9	8. 8± 0. 6	7. 7± 0. 8


Fig. 2. Fragment of experiment Fig.2.1 Fragment of myogram

Table 2

Bio electrical activity of muscles with shin's position at 130 degrees angle

130 degrees	m. vastus medialis		m. rectus femoris		m. vastus lateralis	
	Right leg	Left leg	Right leg	Left leg	Right leg	Left leg
Maximal amplitude (mcV)	6132. 5± 698. 5	5948. 1± 610. 3	10168± 1003. 7	9325± 854. 8	6362. 08± 599. 2	5438. 08± 401. 4

Mean amplitude (mcV)	1163. 62± 115. 7	1025. 38± 100. 7	1583. 49± 128. 1	1234. 51± 105. 4	1270. 6± 110. 3	1184. 6± 105. 4
Mean frequency (Hz)	96. 4± 6. 8	91. 9± 5. 7	118. 1± 6. 6	105. 1± 7. 9	106. 5± 9. 0	99. 8± 8. 1
Comparative coefficient	12. 07± 0. 9	11. 00± 0. 7	13. 41± 1. 2	10. 41± 1. 1	10. 99± 0. 8	9. 83± 0. 7


Fig. 3. Fragment of experiment Fig.3.1 Fragment of myogram

Table 3

Bio electrical activity of muscles with shin's position at 120 degrees angle

120 degrees	m. vastus medialis		m. rectus femoris		m. vastus lateralis	
	Right leg	Left leg	Right leg	Left leg	Right leg	Left leg
Maximal amplitude (mcV)	6816. 96± 599. 4	6211. 85± 471. 6	10075. 2± 902. 2	9895. 4± 891. 1	7468. 8± 600. 6	6974. 1± 615. 8
Mean amplitude (mcV)	1341. 13± 125. 7	1128. 17± 110. 8	1899. 71± 161. 6	1835. 16± 154. 2	1408. 74± 115. 7	1379. 25± 108. 9
Mean frequency (Hz)	94. 9± 8. 9	87. 7± 7. 4	108. 6± 9. 3	100. 2± 8. 4	96. 4± 7. 7	91. 9± 7. 6
Comparative coefficient	14. 3± 1. 4	12. 8± 0. 9	17. 49± 1. 9	16. 35± 1. 5	14. 61± 1. 0	12. 28± 1. 4


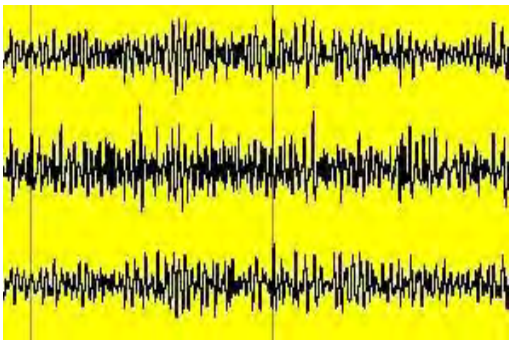

Fig. 4. Fragment of experiment Fig.4.1 Fragment of myogram

Table 4

Bio electrical activity of muscles with shin's position at 120 degrees angle

.

105 degrees	m. vastus medialis		m. rectus femoris		m. vastus lateralis	
	Right leg	Left leg	Right leg	Left leg	Right leg	Left leg
Maximal amplitude (mcV)	7424. 35± 681. 2	6813. 28± 528. 7	10657. 3± 815. 4	10003. 1± 995. 3	8675. 7± 715. 8	7998. 2± 615. 8

Mean amplitude (mcV)	1537. 1± 129. 8	1333. 11± 120. 6	1999. 71± 181. 6	1897. 12± 178. 1	1576. 84± 99. 7	1491. 32± 85. 3
Mean frequency (Hz)	93± 6. 8	85. 1± 7. 7	100. 9± 9. 8	94. 1± 9. 1	92. 8± 8. 3	88. 9± 8. 8
Comparative coefficient	16. 1± 1. 6	14. 8± 1. 1	18. 48± 1. 9	19. 64± 1. 8	13. 7± 1. 3	12. 61± 1. 1

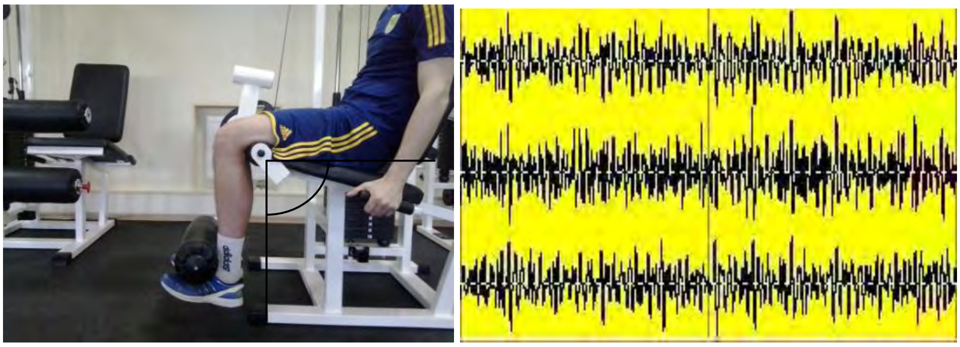

Fig. 5. Fragment of experiment Fig.5.1 Fragment of myogram

Table 5

Bio electrical activity of muscles with shin's position at 90 degrees angle

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90 degrees	m. vastus medialis		m. rectus femoris		m. vastus lateralis	
	Right leg	Left leg	Right leg	Left leg	Right leg	Left leg
Maximal amplitude (mcV)	9840± 821. 1	8473. 65± 728. 7	12159. 36± 1105. 3	11115. 4± 1090. 2	9499. 2± 891. 1	8537. 4± 786. 6
Mean amplitude (mcV)	1831. 45± 156. 9	1643. 52± 141. 4	2464. 88± 239. 4	2107. 76± 220. 2	2031. 32± 179. 4	1990. 31± 159. 9
Mean frequency (Hz)	88. 7± 9. 2	90. 2± 9. 1	96± 7. 6	93. 8± 9. 0	83. 8± 8. 1	87. 7± 8. 9
Comparative coefficient	20. 64± 2. 0	19. 1± 1. 5	25. 68± 2. 2	20. 79± 2. 2	24. 23± 2. 1	23. 15± 1. 8

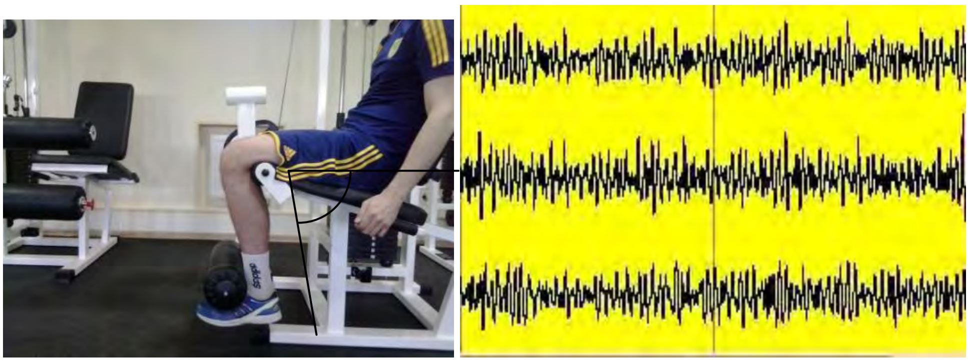

Fig. 6. Fragment of experiment Fig.6.1 Fragment of myogram

Table 6

Bio electrical activity of muscles with shin's position at 80 degrees angle

80 degrees	m. vastus medialis		m. rectus femoris		m. vastus lateralis	
	Right leg	Left leg	Right leg	Left leg	Right leg	Left leg
Maximal amplitude (mcV)	5479. 68± 553. 2	5349. 17± 524. 7	8228. 16± 815. 3	7796. 9± 801. 4	5980. 8± 444. 8	5032. 82± 376. 3

Mean amplitude (mcV)	1393. 42± 129. 7	1223. 38± 112. 8	1591. 26± 144. 4	1478. 72± 131. 7	1548. 47± 127. 2	1492. 83± 149. 0
Mean frequency (Hz)	83. 1± 7. 9	81. 5± 8. 0	91. 4± 8. 2	90. 1± 7. 4	75. 9± 7. 7	69. 8± 5. 4
Comparative coefficient	16. 81± 1. 6	13. 1± 1. 1	17. 41± 1. 8	15. 81± 1. 6	20. 4± 2. 0	19. 3± 1. 8

Summary

Having analyzed IEMG of shin's extensor muscles in sitting position, we can make conclusions that from all examined positions angel at 140 degrees creates the best preconditions for manifestation of muscular force as far as indicators of the lowers mean and maximal (mcV) amplitudes witness about the least closing of actinomycotic filaments in sarcomere; conventional difference of mean amplitude's relations to mean frequency between compared channels is also the least that witness about minimal asymmetry (see Fig.1; 1.1, table1). With bending of shins these indicators increase and reach maximal value with the highest asymmetry when shin is in position at angle of 90 degrees to thigh (see fig. 5; 5.1, table 5) that witness that this angle is a position of maximal actinomycotic filaments' closing in sarcomere of musculus vastus medialis, musculus vastus lateralis; musculus rectus femoris and, in compliance with the theory of Gordon, Huxsley, Julian (1966) and V.M. Zatsiorskiy (1981), which were regarded above, has optimal preconditions for manifestation of muscular force.

The prospects of further researches imply further studying of biarticulated musculus rectus femoris IEMG with changing of thigh's position in relation to torso axis; determination of bio electric activity of uniarticulated musculus vastus medialis i musculus vastus lateralis (as far as knee joint is a combined one and with bending of shin elements of its pronation and supination are added) in the context of special exercises " extending of supinated, pronated shin in sitting position". As far as with the highest indicators of mean and maximal (mcV) amplitudes, we observed the lowest indicators of mean frequency (Hz) and on the contrary, there appears a need in determining of this process's compliance with other muscular groups and its preconditions. Fulfillment of such researches will permit to optimize training process of qualified football players, owing to determination of optimal influence on mobile segment.

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