ELECTROMYOGRAPHY PATTERNS CHANGES AT DIFFERENT CATEGORIES OF PROFESSIONAL SPORTSMEN

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Abstract
Object of our paper was to study the electromyography activity at different categories of professional sportsmen (handball players and volleyball players),tocompare the obtained results and to emphasizedspecific electromyography patterns to each studied sports.
Group of study was formed of 24 male professional sportsmen, 11 handball players and 13 volleyball sportsmen, with at least 6 years experience, in either one of the practiced sports, homogeneous regarding ages, heights and weights.
Were recorded EMG to allathletes, together withmechanogram,during maximum isometric contractions of fingers flexors from both hands. Weused silver surface electrodes and the EMG BIOPAC MP 150 two channels device, with two active electrodes for each channel, the reference onebeing placed on forearm distal extremity, which was connected to a PC Pentium IV, whose program processed the data offered by BIOPAC system.
To improve the interpretation of the obtained parameters, they were divided in 4 categories: of frequency, of mechanogram, of time and mixed and for each one of the parameters, were calculated other characteristic indexes. For most of the mechanogram parameters, handball players presented the highest values and the frequency parameters had superior values for volleyball players.
So, the obtained EMG patterns were different, specific to the type of physical effort, that characterized each studied sports and proved to be an important contributor to sportive performances increasing, by helping the trainers to set adequate professional training programs for each athlete.
Keywords: *electromyography patterns, professional sportsmen, training programs, physical effort*.

Introduction

A recording technique of the action potentials produced by the skeletal muscular fibers during repose state, voluntary muscular contraction and after muscle direct stimulation or nervous fibers that innervate the studied muscle indirect stimulation is named electromyography (EMG) [1].
Object of our paper was to study the electromyography activity at different categories of professional sportsmen (handball players and volleyball players),tocompare the obtained results and to emphasizedspecific electromyography patterns to each studied sports.

Material and methods

Group of study was formed of 24 male professional sportsmen, 11 handball players and 13 volleyball sportsmen, with at least 6 years experience, in either one of the practiced sports, homogeneous regarding ages, heights and weights.
The testing was performed under current ethical rules, each participant being informed of the experimental processes.
The investigations took place in equivalent conditions for all subjects, so, we can affirm that the determining factor for the different results of the administered tests were the changes induced by the practiced sports.
Were recorded EMG to all sportsmen, together withmechanogram,during maximum isometric contractions of fingers flexors from both hands, the force traductor, belongs to BIOPAC system, being a SS25L hand dynamometer, with a isometric interval of 0-100 kg and a nominal output of 20μV/kg.
Weused silver surface electrodes and the EMG BIOPAC MP 150 two channels device, with two active electrodes for each channel, the reference onebeing placed on forearm distal extremity, which was connected to a PC Pentium IV, whose program processed the data offered by BIOPAC system.
The analog/digital conversion was performed with a a 16 biti resolution, at a sample rate of 5000 Hz. PC Pentium IV software is realized by BIOPAC Systems and hardware is under AcqKnowledge license, the AcqKnowledge program allows the filtration, recording and proccessing of the sEMG and dynamometer signal.

Results

To improve the interpretation of the obtained parameters, they were divided in 4 categories: of time (maximum amplitude of the straighten signal rAmax, straighten signal median amplitude

rAmed, straighten signal average amplitude rAav, points return median amplitude of straighten EMG signal rAmed-Ip, points return average amplitude of straighten EMG signal rAav-Ip, root mean square Rms, straighten signal integral Isr, ratio mean area/mean amplitude Raa, power maximum density Smax), of frequency (median frequency Fmed, average frequency Fav, power frequency maximum density Fsmax, Burch median frequency IFmed, Burch average frequency IFav, points return number Npi, passes to zero number Ntz), mixed (medium suddenness of EMG waves Stav, efficiency index of excitation with contraction coupling ECCEI) and of mechanogram (average muscular force Force, force integral Force int.). For each one of the parameters, were calculated other characteristic indexes: intercept, slope, primary indexes and percent variation (percentage ratio slope/intercept), a secondary index, obtained from the primary ones. So, were emphasized specific neuromuscular patterns for time, frequency, mixed and mechanogram parameters, at tested sportive disciplines.

Because were obtained many data and a large amount of values, we used the percentage expression ofthe raw values, recorded for each group, confronted to the ones of the entire lot (that will represent 100%).

For time parameters, the intercept measure, for the three groups of sportsmen, percentage expressed, reveals low values at volleyball players, for most of the studied parameters, handball athletes presented middle values, with 2 exceptions (Table 1).

Table 1. Percentage values of intercept time parameters at studied sportsrelated to the entire lot

	rAmax (mV)	rAmed (mV)	rAav (mV)	rAmed-lp (mV)	rAav-lp (mV)	Rms (mV)	Isr (mV.ms)	Raa (ms)	Smax (mV^2/ms)
Handball	106.37	101.15	102.06	102.91	102.61	102.88	102.81	102.54	97.84
Volleyball	80.51	84.92	84.11	83.56	83.44	83.35	85.89	95.11	104.68

Frequency parameters intercept index analyze, shows the highest values for volleyball group, for most of the parameters, exception Smax, a reverse aspect in confront with the one met at time parameters, the others group presented medium values, with two exceptions (Table 2).

Table 2. Percentage values of intercept frequency parameters at studied sportsrelated to the entire lot

	Fmed (Hz)	Fav(Hz)	FSmax(Hz)	IFmed(Hz)	Nlp (nr/s)	Nzc(nr/s)	IFav(Hz)
Handball	98.23	99.54	118.9	97.09	97.80	102.53	97.94
Volleyball	104.44	100.83	55.13	105.60	104.50	105.51	104.18

For the third parameters category, mixed and mechanogram ones, intercept evaluation pointedthe highest ones at handball players, exception Stav (Table 3).

Table 3. Percentage values of intercept mixed and mechanogram parameters at studied sportsrelated to the entire lot

	Stav(mV/ms)	Force(kgf)	ECCEI (kgf/Hz)	Duration(s)	Force Int.(kgf.s)
Handball	97.51	116.68	118.46	135.95	131.05
Volleyball	90.71	102.63	97.91	87.00	96.90

The values obtained for slope index, sustained the existence of the same pattern, as the one evidenced for intercept index, as showed in Table 4.

Table 4. Percentage values of slope time parameters at studied sports related to the entire lot

	rAmax (mV)	rAmed (mV)	rAav (mV)	rAmed-lp (mV)	rAav-lp (mV)	Rms (mV)	Isr (mV.ms)	Raa (ms)	Smax (mV^2/ms)
Handball	105.21	84.53	84.47	88.85	87.09	85.65	84.67	52.13	51.38
Volleyball	75.67	83.95	82.41	81.21	81.31	81.02	83.55	92.76	106.99

Slope index values measure, reveals highest values for volleyball group, for handball, the values are lower, for most of the frequency parameters, exception Fsmax, as observed in Table 5.

Table 5. Percentage values of slope frequency parameters at studied sports related to the entire lot

	Fmed (Hz)	Fav(Hz)	FSmax(Hz)	IFmed(Hz)	Nlp(nr/s)	Nzc (nr/s)	IFav (Hz)
Handball	58.84	55.20	72.42	55.79	62.56	86.29	75.33
Volleyball	106.32	101.29	46.32	108.76	106.86	102.90	106.37

By measuring the slope index for mixed and mechanogram parameters, were noticed the highest values at the same sport group, as the intercept index one, handball, with the same exception Stav and the volleyball players presented the lowest ones (Table 6).

Table 6. Percentage values of slope mixed and mechanogram parameters at studied sportsrelated to the entire lot

	Stav(mV/ms)	Force (kgf)	ECCEI (kgf/Hz)	Duration (s)	Force Int. (kgf.s)
Handball	79.94	130.06	152.63	135.95	131.05
Volleyball	93.01	87.96	82.68	63.99	73.94

If, in the case of indexes specific to primary parameters, was emphasized a pattern characteristic to each sportsmen group, for secondary indexes obtained through primary parameters processing, the specific changes are structured different.

Was remarked the profile changing, handball players, at all parameters recorded the lowest values and the volleyball ones, almost were identical with the ones of the entire lot (Table 7).

Table 7. Percentage values of percent variation time parameters at studied sports related to the entire lot

	rAmax (mV)	rAmed (mV)	rAav (mV)	rAmed-lp (mV)	rAav-lp (mV)	Rms (mV)	Isr (mV.ms)	Raa (ms)	Smax (mV^2/ms)
Handball	96.33	87.27	86.70	87.56	86.41	86.98	88.27	50.33	55.49
Volleyball	107.33	98.24	99.20	99.40	100.59	99.24	97.45	111.68	148.55

Percent variation values of frequency parameters at volleyball players were the highest, for most of the parameters and for handball sportsmen were the lowest (Table 8).

Table 8. Percentage values of percent variation frequency parameters at studied sports related to the entire lot

	Fmed(Hz)	Fav (Hz)	FSmax(Hz)	IFmed (Hz)	Nlp (nr/s)	Nzc (nr/s)	IFav(Hz)
Handball	55.49	60.14	60.09	59.69	85.99	78.40	67.24
Volleyball	148.51	134.59	133.13	115.66	109.22	118.18	128.25

Table 9. Percentage values of percent variation mixed and mechanogram parameters at studied sports related to the entire lot

	Stav(mV/ms)	Force(kgf)	ECCEI(kgf/Hz)	Duration(s)	Force Int.(kgf.s)
Handball	81.77	103.24	120.22	135.95	131.05
Volleyball	105.21	75.89	48.28	87.00	96.90

Regarding the mixed and mechanogram parameters, at handball group, the percent variation values for duration and force were the highest, while, the otherparameters values were in an intermediary position for volleyball athletes, as in Table 9.

Discussions

Were avoid reactivity differences between beginners and experienced ones, by selecting sportsmen, active for at least 6 years, exclusively in either one of the studied sports. Due to the neuromuscular adaptation, gained by training and competitions, at experienced sportsmen, the motor units activation is very high [2]. The results we obtained can not be compare with the ones from the literature, because, on one hand, the analyze program of the lines is original [3, 4, 5, 6] and on the other hand, there are very few tests performed for the sportive disciplines we choose for our study.

As, the presented results showed, we established electromyography features for each sports, not only for the frequency and mechanogram parameters, but also, for time and mixed ones, that were not evaluated at other studies. Intercept, slope and percent variation indexes values, measured at the studied sport categories for time parameters and related to the entire lot, revealed handball players with the highest value, followed by volleyball players.

At most of the mechanogram parameters, for the ones that express the developed force and the contraction duration, handball players presented the highest values, compare to volleyball, performance due to higher proportion of muscular fibers type I and IIa, that together with a muscular hypertrophia and even a hyperplasia, can explain this characteristic.

Concerning, the frequency parameters, the highest values were present at volleyball players, in comparison with handball athletes, taking into account, that these one, perform an effort partially aerobic, partially anaerobic, the morphology support being preponderantly represented by type I and IIa muscular fibers [4, 5].

Thus, measuring the values of time, frequency, mixed and mechanogram parameters, characteristic patterns for each tested sport were emphasized.

Conclusions

The obtained EMG patterns were different, specific to the type of physical effort, that characterized each studied sports and proved to be an important contributor to sportive performances increasing, by helping the trainers to set adequate professional training programs for each professional sportsmen.

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