THE BIOELECTRIC ACTIVITY OF MUSCLE *PECTORALIS MAJOR* IN PRESSING FROM A LYING POSITION

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The bioelectric activity of muscle *pectoralis major* was recorded with the help of surface EMG. The aim of this work was to determine participation of three parts of this muscle in motor task realization i.e. the pressing of a barbell in a lying position. Despite a suitable competitors' selection (the first class) and a similar way of task realization (the 'bridge' technique) some competitors indicated a large activity in central part of the muscle whereas the others in lower or upper part. Average bioelectric activity of three parts of muscle together, in all subjects, was larger in pressing phase than in lowering phase during the press in a lying position. It may mean, that the way of trial realization is also affected by other factors, i.e. the radius of "bridge" curvature or trajectory motion of barbell.

KEY WORDS: EMG**,** muscle *pectoralis major*, barbell press

INTRODUCTION: All motor actions, and the natural ones such as locomotion movements as well as more elaborate/sophisticated ones e.g. pressing of the barbell in a lying position, have their own causes. Kinetic parameters such as e.g. force or its moment, which can be generated by definite groups of muscles, belong to them. There is a close relationship between bioelectric activity of muscle (EMG) and the force produced by it (Fuglevand et al., 1993). The investigation of bioelectric activity of muscles delivers the information about nervous activity as well as the generated, in this way, patterns of muscles co-ordination. The proper patterns of co-operation of definite muscles groups are, however, the basis of correct course of motor actions. To determine neuromuscular co-ordination, in physical education and sport, the registration technique of muscular signals from the surface of the skin (surface electromyography) is used because of its noninvasive character. The recorded signal comes into being in result of temporal and spatial summations of functional potentials of active motor units being in registration area of electrodes. From among two basic (applied in surface electromyography) configurations of electrodes, bipolar (differential) configuration is used more frequently than unipolar one, because of smaller electric disturbances (Cram and Kasman, 1998). Bioelectric voltage recorded with the help of bipolar electrodes is an entirely transformed signal of activity of motor units, which amplitude and shape cannot be foreseen. As Błaszczyk (2004) claims characteristics of these signals depend, among other things, on:

1. Characteristics and number of muscle fibres in registration area of electrodes,
2. Configuration of electrodes.
3. Distances of active fibres from electrodes.
4. Changes of muscle shape in time of movement.
5. Place of position and orientation of electrodes.

The last factor was of major importance in this study. It is true that De Luca (1997) described the best places for fixing electrodes over the muscle, however the did not do it for one of the most important, as it seems, during the barbell press in a lying position, muscle i.e. *pectoralis major*. Thus, the aim of the study was the qualification of three parts of *m. the pectoralis major* participation in motor task realization i.e. pressing of the barbell when lying on a small horizontal bench.

MATERIAL AND METHODS: Seven competitors with high sport level participated in investigations (Tab. 1). All subjects gave their written consent to participate in them.

Tab. 1 Characteristics of studied powerlifting competitors

Objects/Competitors [initial]	Year of birth	Height of body [cm]	Body mass [kg]	Sport class	Best result	Training practice [years]
Z.G.	1984	171	92,0	First	3p. PJC	6
P.M.	1983	171	60,0	First	3p. PJC	2
D.Ł.	1978	176	81,2	First	4p. PSC	10
Wa.M.	1984	174	79,0	First	2p. RC	1,5
O.K.	1981	163	76,0	First	3p. PJC	6
T.M.	1980	165	69,0	First	3p.PSC	5
Wi.M.	1981	169	91,0	IC	2p. WC	10

where: PJC- Polish Junior Championships, PSC- Polish Senior Championships, RC- Regional Championships, WC- World Championships, IC- International Championships Class

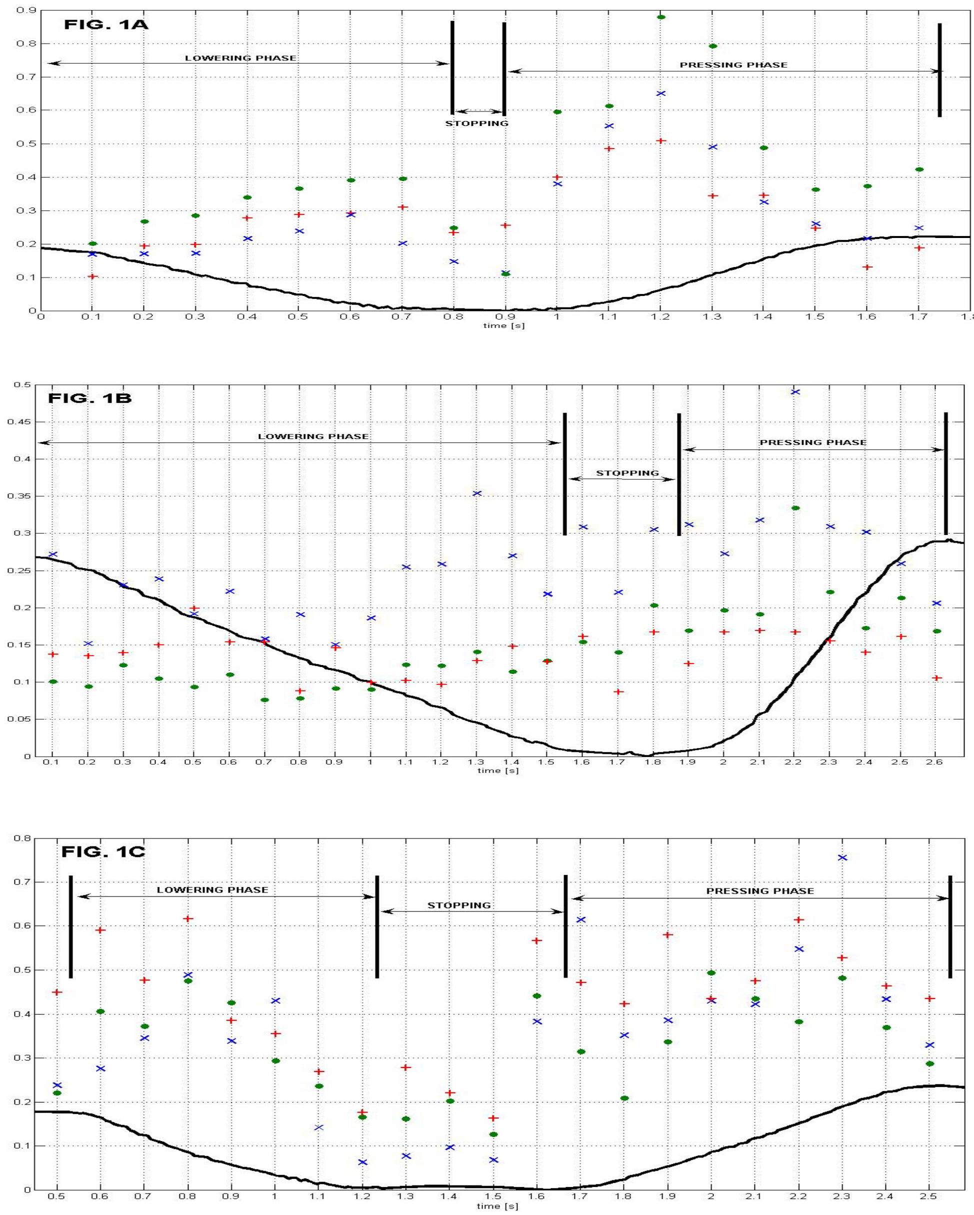
After a general and special warm up it was determined, in static, in which position of electrodes (external, central whether medial) the muscle *pectoralis major* showed the largest activity (As it was shown in earlier investigations (Król et al., 2006), it is an individual matter, though most frequently it has been a medial position of electrodes.) To register bioactivity Axon Instruments equipment was used (CyberAmp 380 amplifier: CMRR 110dB, sample frequency 1kHz, input resistance 1MΩ, input capacitance 45pF, notch filter; A/D card DigiData 1200; special wires AI 417; Axotape software). Bipolar surface electromyography was applied with the use of standard 1cm diameter electrodes (Ag-AgCl, type EK-S30PSG, Sorimex, Poland) about 2cm distant from each other. They were fixed in every of three parts of muscle (clavicular - C, sternal - S and abdominal - A), along muscle fibres. Apart from EMG signal vertical position of the barbell movement were registered with the help of pantograph[2], which enabled division of the motion into such phases as: lowering, halt and, separately for each press. Recorded EMG signal underwent digital integration (IEMG) with constant 0,1s time window part of the muscle. Next, the average value of IEMG for the whole motion, and in every phase was calculated. As the time of lowering and pressing phase depends on a competitor and the barbell weight, a special IEMG coefficient was calculated (C_{lph} – for lowering phase, C_{pph} – for pressing phase):

$$C_{lph} = \frac{\sum_{i=1}^{3} IEMG_i}{3 * n_{lph}}; \qquad C_{pph} = \frac{\sum_{i=1}^{3} IEMG_i}{3 * n_{pph}}$$

where: i – part of muscle (C, S, A); n – number of 0.1s time intervals for lowering (lph) and pressing (pph) phase.

Competitors kept pressing the barbell with increasing mass until its maximum value was defined which constituted 100% capacity/ability on the very day of research. It was accepted as maximum (1RM; repetitions maximum). Then 70, 80 and 90% of 1RM load were defined and competitors performed one trial with that load. Competitors used "bridge" technique of the barbell press. The width of barbell hold was constant and was 81cm for all subjects. That is the greatest width of barbell hold allowed by regulations of International Powerlifting Federation.

RESULT AND DISCUSSION: Despite a suitable competitors' selection (the first class) and a similar way of task (the 'bridge' technique) realization, a similar activity of particular muscle parts was not found in examined competitors. Presented figures indicate large bioelectric activity of muscle pectoralis major in the following parts: sternal (Wi.M. and P.M.; Fig. 1A), abdominal (Z.G. and D.Ł.; Fig. 1B) or clavicular (O.K.; Fig. 1C). In two remaining cases, (Wa.M. and T.M.) no clear trend was observed. This variety may result from the influence of other, apart from the above mentioned i.e. the “bridge” technique and equal width of barbell hold, factors. We mean here, among others, the radius of "bridge" curvature and trajectory of barbell motion resulting from the change of relative angles in shoulder and elbow joints. These factors undoubtedly influence the load in particular joints, which in turn, as numerous investigations show, affects bioelectric activity level of muscles (De Luca, 1997; Błaszczyk, 2004). Average bioelectric activity of three parts of muscle together, in all subjects, is larger in pressing phase than in lowering phase (Fig. 1A). The results of Wilcoxon Matched Pairs Test for calculated coefficients (Tab. 2) proved that observation.



Description of symbols:

vertical position of barbell [m]

value of IEMG for clavicular part of muscle [Vs*10^-4]

value of IEMG for abdominal part of muscle [Vs*10^-4]

value of IEMG for sternal part of muscle [Vs*10^-4]

Fig. 1 Bioelectric activity of muscle (after integration – IEMG) in the 0,1s time intervals and vertical position of barbell during the press in a lying position: A – competitor Wi.M., B – Z.G., C – O.K.

Tab.2 The results of Wilcoxon Matched Pairs Test for bioelectric activity of particular parts of the m. pectoralis major depending on the load

Load [%]	Pair of variables	N number of trials	T	Z	p
70	C_{lph} ; C_{pph}	7	0,00	2,3664	**0,0180**
80	C_{lph} ; C_{pph}	7	0,00	2,3664	**0,0180**
90	C_{lph} ; C_{pph}	7	3,00	1,8593	0,0630
100	C_{lph} ;C_{pph}	7	0,00	2,3664	**0,0180**
Together	**C_{lph} ; C_{pph}**	**28**	**4,00**	**4,5315**	**0,00001**

where: C_{lph} – coefficient of IEMG during lowering of the barbell,
C_{pph} – coefficient of IEMG during pressing of the barbell
N – number of good trials,
T – value of Wilcoxon's test for groups with number of subjects n < 25,
Z – value of Wilcoxon's test for groups with number of subjects n > 25,
Bold – significant at 0,05 level

The average bioelectric activity of three parts of the muscle together increases with the load increase in all subjects. Although, the variance analyses showed that the electromyography activity depended significantly on the load (p<0.019) only in lowering phase. It confirms the results obtained with regard to global activity of main muscles during the barbell snatch (Nawrat et al., 1990).

According to the rules for the pressing from a lying position, the barbell should be stopped in the lowest bottom position. All competitors to a smaller or bigger degree signaled the moment of stopping (Fig. 1 A, B, C). The clear trend of changes with increase of pressing barbell weight was not found. However, a definite trend of changes was observed with reference to the phase of barbell press; generally, the larger the weight of the barbell, the longer the phase duration. The bioelectric activity of muscle was different in the phase of stopping. Wi.M., for example, reduces significantly the activity of the muscle (Fig. 1A) while Z.G. are not able to relax muscles in this phase (Fig. 1B).

CONCLUSION:

- Competitors realized the motor task, which was set for them, in a different way i.e. pressing the barbell in a lying position they engaged different parts of muscle *pectoralis major*.
- Larger bioelectric activity was observed during the pressing phase than the lowering phase.

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