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TWITCH AMPLITUDE AFTER THREE REPETITIONS OF EXHAUSTING ISOMETRIC CONTRACTIONS AT DIFFERENT STARTING INTENSITIES DOES NOT CHANGE

INTRODUCTION

The twitch is the force-time response of the muscle to the single excitatory input (Enoka, 2003). This input is usually an action potential provoked by the nervous system, however artificial stimulus can be evoked by using the electro stimulation. With this purpose single electric shock is usually generated to provoke muscle response. Three measures can be extracted out of a single twitch. The time from force onset to peak force was labelled contraction time and can tell us whether the muscle response is slow (time to peak is long), or fast (time to peak is short). This way the type of muscle can be noninvasively roughly estimated. The second measure is amplitude of the peak force ant the third is the half-relaxation time, which takes the time for the force to decline from its peak value to the half of it.

The constant response of the muscle to the constant intensity electric shock of an intact muscle is expected in controlled conditions. However it was shown that the peak force amplitude of a twitch decline due to fatigue. This mainly happens due to the impairment of cross bridge function which was attributed to the accumulation of Pi ions (Edman 1995; Westerblad et al. 1998) during fatiguing muscle contractions, however some other reasons might be the cause.

Therefore the amplitude of a twitch presents one of the measures that can be used to evaluate peripheral muscle fatigue.

The aim of the study was to evaluate peripheral fatigue by analysing twitch amplitudes after the isometric muscle contractions of different starting intensities at 60 %, 80 % and 100 % of maximal voluntary contraction.

METHODS

Twelve male students (22.2 ± 2.6 years of age) volunteered for the study. After they were fully explained the aim and methods of the study they all signed a form of consent.

Subjects were set on the table with an arm in 90° shoulder abduction and a 90° elbow flexion as shown on the Figure 1. The arm just above the wrist was fixed to the lever which was attached to the force sensor. In this position the subject activated triceps brachii muscle (TB) and performed isometric elbow extension.

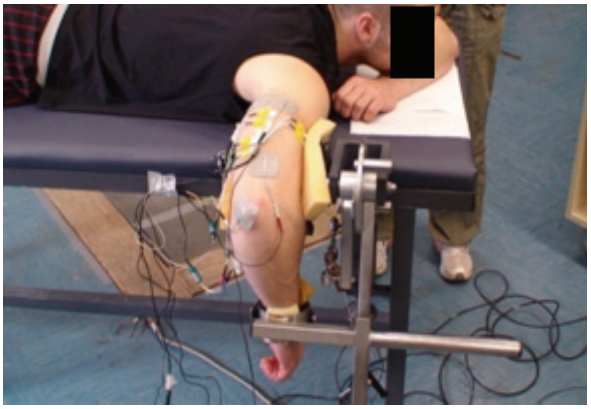

Figure 1. *The position of the subject.*

After standardized warm up the subjects performed maximal voluntary contraction (MVC). The maximal torque measured this way was used to determine torques at 60%, 80%, or 100% MVC, which were used in fatiguing protocols. Ten seconds after the MVC two single electrical impulses (0,3 ms) were delivered to evoke potentiated muscle twitches. The highest peak amplitude of both twitches was used as a normalizing value for the peak amplitudes of a twitches measured 10 seconds after every fatiguing contraction. For the electric stimulation we used two electrodes (Axelgaard, Fallbrook, CA, size 5 x5 cm) on the proximal end and one electrode at the distal end of a muscle.

The subjects performed three different fatiguing protocols in three different days (at least one week in-between) in a random order. Each fatiguing protocol consisted of three consecutive isometric contractions with a one minute rest in-between. The starting intensities of contractions were set at 60%, 80% or 100% for fatiguing protocols FP60, FP80 and FP100 respectively.

The torque and the time to the lowest torque were measured. Subject performed isometric arm extension until exhaustion. The moment of exhaustion was defined as the time point when the torque did not further decrease. When torque decreased to the stable lowest value, the contraction was stopped. Ten seconds after the contraction had been stopped the muscle was stimulated with two single electrical impulses and two muscle twitches were provoked. The torque at the end of fatigued contraction and higher of the two twitch amplitudes were used for further analysis.

Descriptive statistics and repeated measures ANOVA were computed using SPSS software to find the differences between the variables. The confidence interval was set at 0.05 and 0.001.

RESULTS

The times to exhaustion decreased in every consecutive contraction (Figure 2).

For the protocol FT60 the time to exhaustion (TE) of the first contraction differed from the respective times of the second and third contraction and the TE of the second contraction differed from the third ($P < 0.001$),. At the protocols FT80 and FT100 the TE of the first contraction differed from the TE of second and third contraction ($P < 0.001$), however the TE of the second and third contractions did not differ ($P = 0.232$, $P = 0.329$ for FP80 and FP100 respectively).

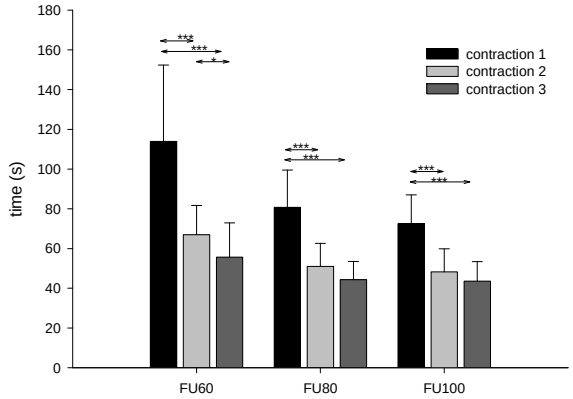

Figure 2. *The times to exhaustion in three consecutive isometric contractions for three different fatiguing protocols (FU60, FU80, FU100).*

The differences of the TE of the first contraction between the FU60 and FU80 were close to statistical significance (P=0.079)

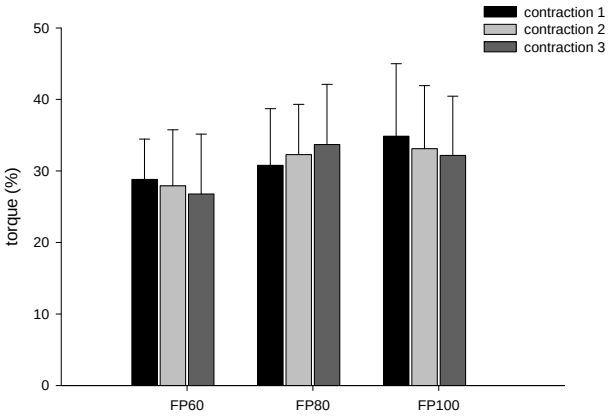

Figure 3. *The comparison of the torques at the end of three consecutive isometric muscle contractions for three fatiguing protocols(FP60, FP80, FP100)*

The comparisons of the torques at the end of contraction for all three isomeric protocols are shown in the Figure 3. The average values of the three consecutive contractions ranged from 27.8 ± 1.0% MVC for FP60 to 33.4 ± 1.4% for the FP100, however no statistically significant differences between the values were found.

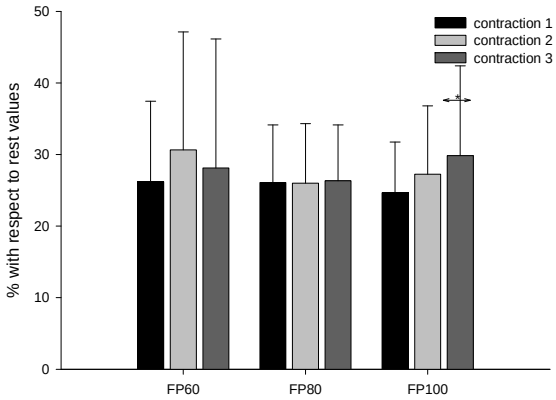

Figure 4. *The comparison of the torques of the twitches measured at the end of contractions. Torqueses are expressed in percentage with respect to the initial resting value.*

The twitch amplitudes expressed in percentage with respect to the initial value obtained in rested muscle are shown in Figure 4. No differences between the three consecutive contractions and no differences between three different protocols were found (P = 0.285).

DISCUSSION

The comparison of the amplitudes of the muscle twitches provoked after three consecutive exhausting isometric contractions with different starting contraction intensities (60% MVC, 80% MVC, and 100% MVC) did not show any statistically significant differences.

The amplitude of the muscle twitch provoked by the single electrical impulse is one of the measures of the peripheral muscle fatigue. Other tests such as the muscle response to the train of low and high frequency impulses and/or the analyses of the elicited M-waves, as well as some physiological parameters are often used to gain more precise information about peripheral fatigue. Our results suggest that the amount of peripheral fatigue accumulated in the TB after isometric contractions of different intensities until exhaustion was approximately the same. As well as the twitch amplitude measured after exhausting contraction, the final torque produced by the muscle performing isometric contraction, does not depend on the contraction history. Nevertheless the muscle was previously contracting (such as in three consecutive contractions) and with

any of three different starting intensities (60% MVC, 80% MVC or 100% MVC), the final torque produced by the muscle was approximately the same. The torque at the end of isometric contractions decreased to 31.6 ± 8.3 % MVC, which is in accordance with 58% decrease reported by Babault et al (2006) after maximal isometric knee extension.

However, according to expectations, the time to exhaustion (TE) decreased if muscle had been previously fatigued. The TE also decreased with respect to the increase of initial intensity of isometric contraction; TE was significantly shorter when starting intensity was 100 % MVC with respect to the contractions when starting intensities were 60 % MVC and 80 %MVC.

Shorter TE measured in the second and third contraction implied that one minute rest interval was not long enough for muscle to recover. Rainoldi et al. (1999) showed that for the isometric contraction at 50% MVC and 70% MVC even 5 minutes of rest was not enough for the full recovery of the muscle force, while Bilcheck et al 1993 reported that muscle force after one minute rest regenerated up to 75 % and another 2-3 minutes were needed for complete recovery.

CONCLUSION

The analysis of the amplitudes of the muscle twitches provoked after sustained isometric contractions of triceps brachii muscle at different starting intensities as well as the torque at the end of contractions, showed no differences implying therefore no differences in accumulating peripheral fatigue in the muscle.

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The amplitude of a twitch presents one of the measures used to evaluate peripheral muscle fatigue. The aim of the study was to evaluate peripheral fatigue after the isometric muscle contractions of different starting intensities: at 60 %, 80 % and 100 % of maximal voluntary contraction. Twelve male students (22.2 ± 2.6 years of age) performed three fatiguing protocols in three days. Each fatiguing protocol consisted of three consecutive isometric contractions with a one minute rest in-between. The starting intensities of contractions were set at 60%, 80% or 100% for fatiguing protocols FP60, FP80 and FP100 respectively. Torque and duration of contractions and the amplitude of the muscle twitches provoked after the fatiguing contractions were measured. The comparison of the amplitudes of the muscle twitches provoked after three consecutive exhausting isometric contractions with different starting contraction intensities (60% MVC, 80% MVC, and 100% MVC) as well as the torque at the end of contractions did not show any statistically significant differences. In conclusion, no differences in accumulated peripheral fatigue were found after isometric contractions of different starting intensities.

Key words: *isometric contraction, muscle fatigue, twitch, amplitude*

„Dan“, 29. mart 2010.

У СУСРЕТ НАУЧНИМ СКУПОВИМА ЦРНОГОРСКЕ СПОРТСКЕ АКАДЕМИЈЕ

Преко 300 учесника

На Конгресу Црногорске спортске академије, који ће се од 1. до 4. априла одржати у Херцег Новом биће преко 250 аутора и коаутора на овогодишњим радовима и за три дана трајања скуп ће посјетити преко 300 учесника. До сада смо објавили наслове 109. радова, а у данашњем објављујемо још осам: **110. Небојша Чокорило, Милена Микалачки, Даринка Коровљев** (Факултет спорта и физичког васпитања, Нови Сад): **„Програм вјежбања са теговима и тренажерима методом станица прилагођен женском полу"; 111. Даринка Коровљев, Милена Микалачки, Небојша Чокорило: „Систематизација основних корака степ аеробика";** 112. проф. др **Енвер Међедовић, Бенида Међедовић** (Државни универзитет, Нови Пазар), мр **Ахмет Међедовић** (Медицинска школа)**: „Вјежбе обликовања у структури часа тјелесног вјежбања"; 113. Бенида Пљакић** (Државни универзитет, Нови Пазар), проф. др **Зоран Момчиловић** (Учитељски факултет Врање), **Сабина Зејнелагић** (Државни универзитет, Нови Пазар): **„Дидактичко-методички осврт на књигу Методика физичког васпитања аутора проф. др Енвера Међедовића"; 114. Бранко Скоф, Ирена Ауерспергер** (Факултет шпорта, Љубљана), **Рок Благус** (Медицински факултет, Љубљана), **Бојан Кнап, Милан Скитек, Алеш Јерин** (Универзитетски медицински центар, Љубљана): **„Утицај шестонедјељног вјежбања на стање гвожђа код тркачица"; 115. Абедин Ибрахими, Вилдане Јашари** (Косово), **Осман Лачић, Јасмин Мехиновић** (Факултет за тјелесни одгој и спорт, Тузла): **„Ефекти програмских оператора као резултат квантитативних промјена морфолошких карактеристика и моторичких способности студената"; 116. Ненад Мачванин** (Висока струковна школа за предузетништво, Београд), **Паулина Солдат** (Предшколска установа „Радосно дјетињство", Нови Сад), **проф. др Ђорђе Мачванин** (Универзитет „БК" Београд, Факултет за менаџмент у спорту)**: „Шта је допинг"; 117. Жарко Костовски** (Факултет физичке културе, Скопље), **Адем Прељевић** (Универзитет Нови Пазар), **Сејлејман Шаља** (Факултет тјелесног одгоја и спорта, Приштина): **„Утицај одређених тестова за оцјену базичне моторике на тест СХЦ за оцјену специфичне карате координације".**