THE MUSCLE ADAPTATION PROCESS AS A RESULT OF PATHOLOGICAL CHANGES OR SPECIFIC TRAINING PROCEDURES

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Abstract: Muscle responses to tetanic electrical stimulation were detected by the non-invasive tensiomyographic (TMG) measuring method. The main objective of this study was to find out whether the TMG measuring method is suitable for monitoring the unfused tetanus (stimulation frequencies ranging from 1 Hz to the fusion frequency (f_f) – the frequency at which tetanus occurs), and whether this monitoring provides any information on skeletal muscles' structural or functional changes. The muscle adaptation process was observed in damped unfused tetanus (DUT). The measured results in the clinical environment as well as on the sports field indicate that DUT is caused by a type II muscle fibres fatigue process. Separate observation of type II muscle fibres enables more efficient treatment and observation of pathological changes, and helps professional athletes and their trainers to better understand the influence of training stimulii on the training process.

Key Words: Muscle Fibres, Tetanic Electrical Stimulation, Tensiomyography, Poliomyelitis, Sports Training

INTRODUCTION

Both clinical and sport physiologists have always been interested in studying muscle adaptation processes as a result of either pathological changes or targeted training procedures. According to the literature, the excitability of type II muscle fibres in fatigued muscle increases [1], which is reflected in the decrease in contraction time. From preliminary research (Dahmane *et al.*, 2001 and Praprotnik *et al.*, 2000) and the form of the biomechanical twitch response recorded immediately after tetanic stimulation, we concluded that: biomechanical response recorded immediately after tetanic stimulation includes responses of (1) non-fatigued type I muscle fibres and (2) fatigued type II muscle fibres. The latter statement is based on the diminished contraction time (10%-90% Dmax) and the amplitude of the biomechanical response (Dmax). On the basis of this conclusion and the above stated facts we have interpreted DUT as a type II muscle fibre fatigue process.

METHODS

Muscle responses to surface bipolar electrical stimulation were detected by the non-invasive measuring method called tensiomyography (TMG) [2]. Displacement of the muscle belly is measured with the displacement sensor, positioned radial to the skin above the observed muscle. In previous studies, it was established that radial displacement is proportional to muscle force (Valenčič, 1990), as well as to the percentage of type I muscle fibers (Dahmane et al., 2001). Muscle response was observed in damped unfused tetanus (DUT) (Fig. 1). As the stimulation frequency increased, the twitches began to sum and the response profile changed from separate twitches to unfused tetanus. All the measurements were performed under isometric conditions. Supra-maximum electrical stimulation consisted of pulse trains. During the monitoring process, the pulse width and pulse frequency (stimulation frequency) were held constant at d = 0.1 ms and f_s = 5-20 Hz, respectively.

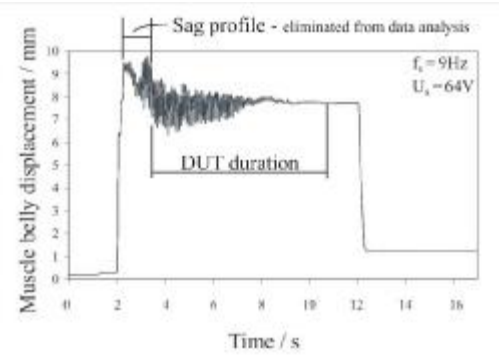

Fig.1: Damped Unfused Tetanus.

RESULTS AND CONCLUSION

In the clinical environment, the above mentioned measuring procedure was applied in muscle rectus femoris with (N=30) subjects after poliomyelitis (p), and compared with a control group (N=30) (c). The stimulation frequency (f_s) was defined with respect to the fusion frequency (f_s=f_f – 2 Hz), ranging from 6-12 Hz. When compared to the EMG output, the TMG method provided useful data on muscle structural changes as well (average values): **DUT duration**: t_p=35.5 s, t_c=73.3 s, (P < 0.05); **DUT frequency**: f_{DUTp}=8.3 Hz, f_{DUTc}=12.3 Hz, (P = 0.02).

On the sports field, the described procedure (f_{DUT}=f_s = 10 Hz) is used to monitor the adaptation of the motor system to specific training procedures. In muscle vastus lateralis of 10 sportsmen, the effect of a specific 10-day-endurance-

oriented training procedure was observed: **DUT duration**: t_{pre}≈22 s, t_{post}≈39 s; **maximum peak-to-peak value** in DUT oscillation: d_{maxpre}=1.1 mm, $d_{maxpost}$=2.3 mm.

With the presented TMG method, the twitch summation, the fused and unfused tetanus in single human skeletal muscle can be monitored. We assume that DUT is caused by type II muscle fibre fatigue process. However, additional measurements are to be performed in order to evaluate the fatigue process in electrically stimulated muscle, and to standardize the measuring procedure and define relevant DUT parameters.

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