The Effects of Rest Interval on Electromyographic Signal on Upper Limb Muscle during Contraction

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Abstract— **In this paper, the Electromyographic (EMG) signal was investigated on the Biceps Brachii muscle during dynamic contraction with two different rest intervals between trials. The EMG signal was recorded from 10 healthy right-arm-dominant young subjects during load lifting task with a standard 3-kg dumbbell for 10 seconds. Root mean square (RMS) has been used to identify the muscle function. The resting period was 2- and 5-minutes between each trial. The statistical analysis techniques included in the study were *i*) linear regression to examine the relationship between the EMG amplitude and the endurance time, *ii*) repeated measures ANOVA to assess differences among the different trials and *iii*) the coefficient of variation (CoV) to investigate the steadiness of the EMG activation. Results show that EMG signal is more active after 5 minutes rest period compare to 2-minutes gap. On the other hand, EMG signals were steady during 2-minutes rest (7.59%) compare to 5-minutes resting interval (16.14%). Results suggest that moderate interval between each trial is better to identify the muscle activity compare to a very short interval. The findings of this study can be used to improve the current understanding of the mechanics and muscle functions of the upper limb muscle of individuals during contraction which may prevent from muscle fatigue.**

Keywords— **EMG, RMS, rest interval, muscle, contraction.**

I. Introduction

Analysis of EMG signal has been given a lot of attention in the last few decades since the investigation and processing of the signal have a huge influence in developing adaptive control of prosthetic devices in the rehabilitation program as well as in diagnosis of neuromuscular diseases. Generally, EMG signal is used to identify the electrical activity from the skeletal muscles during contraction and body movement and, it provides the detail information about the structure and function of these muscles [1]. One of the major issues reported in recent years is the signal effect on muscle during inter-trial rest intervals [2, 3] while recording the EMG signal. The reason is, lack of proper knowledge of the approximate time duration, between each trial, may result in muscle fatigue, soreness, stiffness and even muscle cramp.

Usually, researchers prefer different time duration as rest interval between each trial during EMG recording. For example, 5 seconds [4], 1 minute [4-6] and 5 minute [7]. However, few studies have shown the significance of same time duration between each experimental trial. For example, Maia et al., investigated EMG signals from lower limb muscle with a rest interval of 30 seconds, 1 minute, 3 minutes and 5 minutes [8]. Authors found that no rest or relatively shorter rest intervals (30 seconds and 1 minute) might be more effective to stimulate greater agonist repetition enhancement and muscle activation. Furthermore, Pincivero et al. examined the effects of rest interval (5, 40 and 160 sec) on quadriceps femoris muscle activation [17]. The effects of rest interval length on bench press performance with an interval of 1, 2 and 3 minutes were investigated in [19]. In this consequence, the effect of rest interval for muscle characteristics identification during different contractions (isometric, eccentric, concentric and isokinetic) and from different muscles (upper- and lower limb) were investigated in [9-11].

Moreover, having the significant effect of rest interval on EMG activity, a number of feature extraction methods have been used to investigate the muscle functions. For example, root mean square (RMS), zero crossing, mean frequency, median frequency, average-rectified value (ARV), integrated EMG (IEMG), mean absolute value (MAV), normalized spectral moments, wavelet transforms, increase in synchronization (IIS) index and fractal dimension are more frequently used time and frequency domain techniques. However, no study has been found investigating muscle activity as well as the signal variation on Biceps Brachii (BB) muscle during two rest interval period of 2 and 5 minutes. Also, RMS feature extraction technique has not been given much attention in such kind of investigation. In this study, we investigated the muscle activity during specific rest interval period using RMS feature extraction method. We investigated the effects of two different rest intervals on EMG activity in upper limb muscle during dynamic contraction. Specifically, 2 min and 5 min rest interval were considered as a short and a long resting period respectively. Results found in this study may be useful for further investigation on muscle fatigue during contraction.