Rate of Muscle Fatigue During Cardiopulmonary Resuscitation Chest Compressions

Katelyn Necco; Kelly Helm PhD
Valparaiso University Department of Kinesiology

Abstract

The performance of cardiopulmonary resuscitation (CPR) chest compressions on a patient provides critical blood flow and oxygen delivery to the heart and brain[1]. The objective of this study was to establish the relationship between the rate of muscle fatigue and chest compression performance. The hypothesis stated that if performance of chest compressions cause fatigue after two minutes, then the rate of muscle fatigue will be indicated through surface electromyography (sEMG) measurements. Four participants (M=2, F=2) volunteered to perform chest compressions on a CPR mannequin. sEMG electrodes were placed on the dominant limb anterior deltoid muscle to capture muscle activity while performing chest compressions. Each participant completed 4 sets of CPR chest compressions with a 2-minute rest period between sets. Data was analyzed through the iWrox LabScribe™ software. The root mean square and maximum amplitudes for each signal were collected for data analysis. The mean percent decline was calculated for each set of chest compressions in 3-minute intervals for each participant. The mean percent decline was found to be 17.19% across all participants. Examination of the rate of decline between subjects, indicated the presence of muscle fatigue. The hypothesis was therefore accepted; muscle fatigue was shown through sEMG measurements while CPR chest compressions were performed.

Introduction

Muscles become fatigued because performing CPR is a physically demanding task. The AHA currently recommends, if resources are available, to switch rescuers every 2-minutes while performing CPR so that adequate chest compressions are maintained.[1] EMG research supports the recommendation of switching every 2-minutes as studies show muscle fatigue occurs in rescuers at 2-minutes.[2] Exercise-induced muscle fatigue can develop under a maximal and sub-maximal intensity exercise. Performing chest compressions for 2-minutes is considered an anaerobic exercise that induces muscle fatigue.[3] This study was designed to investigate the relationship between muscle fatigue and performance of chest compressions. The muscle targeted was the anterior deltoid on the dominant arm of the participant.

Figure 1

Participants performing CPR chest compressions

Methods

Setting

- Fitness Lab at a small Midwest university; Spring 2020

Participants

- 4 (M=2,F=2) volunteers experienced with CPR chest compression performance

Procedures

- sEMG electrodes placed on participants' dominant anterior deltoid
- Performance of 2-minute chest compressions with 2-minute rest, repeated 3 times
- Root mean square and minimum and maximum amplitude of muscle activation analyzed
- Mean amplitude percent decline calculated

Results

Table 1

Mean muscle activation across all four 2-min. trials

	RMS				Maximum Amplitudes (mV)			
n	1	2	3	4	1	2	3	4
4	0.15	0.25	0.16	0.2	0.82	1.55	0.91	0.99

Table 2

Percent rate of decline across all participants

n	1	2	3	4	x̄
4	21.93	13.98	6.13	26.72	17.19

Table 1 indicates the decline of the root mean square which further indicate the decrease in muscle activation. The individual maximum amplitudes of each participant vary within each trial and do not confirm a rate of decline. The information in Table 2 displays that each participant demonstrated a decrease in muscle activation in the dominant anterior deltoid through the first and last maximum amplitudes. Table 2 also presents the average percent decline of muscle activation across all participants of 17.19%. The sEMG data collected therefore indicated a decrease in muscle activation across all participants.

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Results cont.

Figure 2

Condensed last 4th set of chest compressions

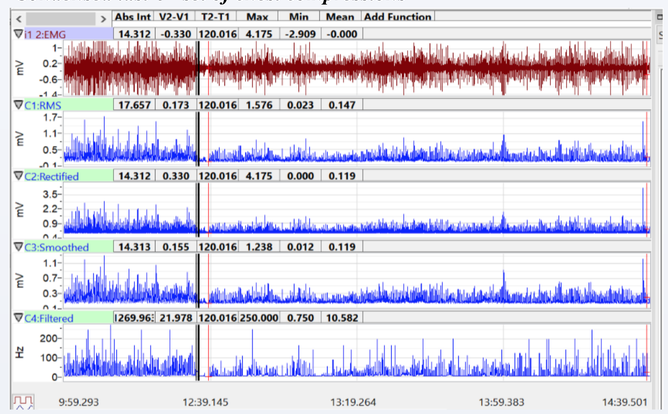
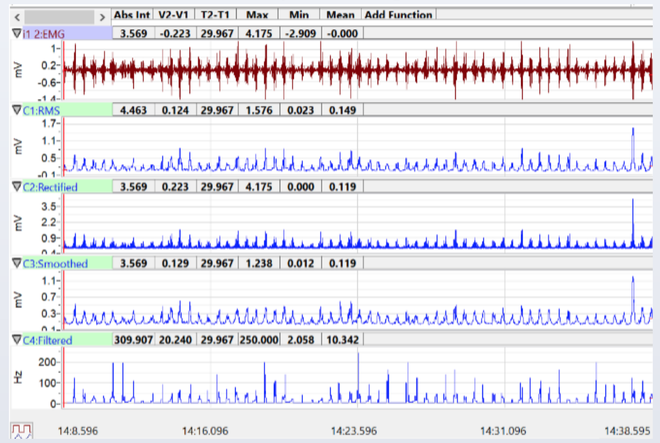


Figure 3

Processed last 30 s. 4th set of chest compressions



Conclusions

This study provides data on the rate of muscle fatigue during CPR chest compression performance. Percent decline of 17.19% across all participants was found and therefore, it is concluded that performance of chest compressions does cause muscle fatigue after several minutes. This conclusion was supported by the calculated percent decline of muscle activation which was seen through the collected sEMG measurements. Therefore, the hypothesis of this study that if performance of chest compressions cause fatigue after several minutes, then the rate of muscle fatigue will be indicated through sEMG measurements, is accepted. Future research could examine differences in muscle fatigue in varying muscle groups.

References

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