

Impact of TENS Therapy on Acute Pectoralis Major Recovery

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Introduction

- Neuromuscular fatigue: caused by inadequate oxygen and energetic changes in muscles
- Standardized method for measuring muscle strength: MVC
- TENS: found to reduce muscle fatigue

NEUROMUSCULAR FATIGUE

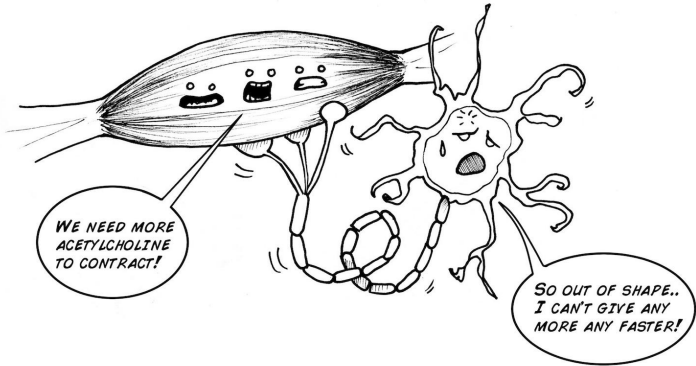


Image: [2]



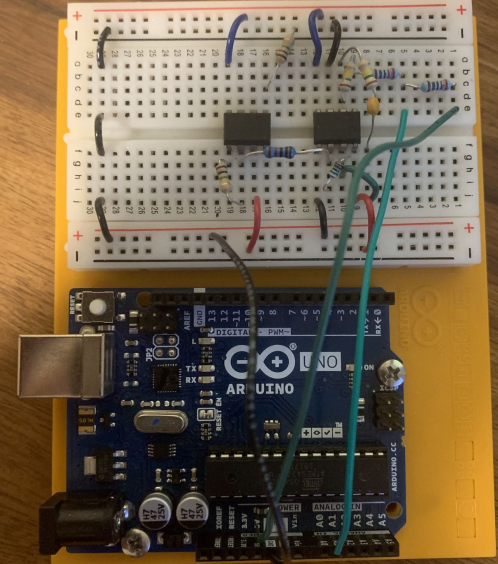
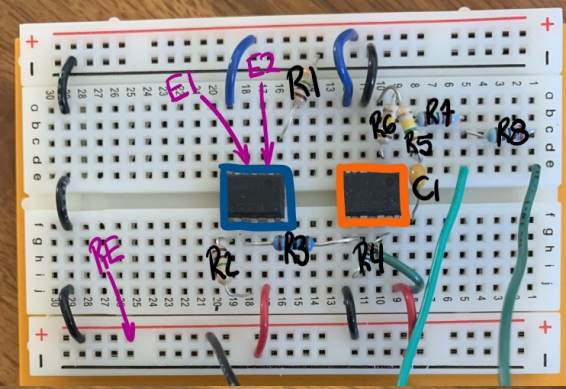
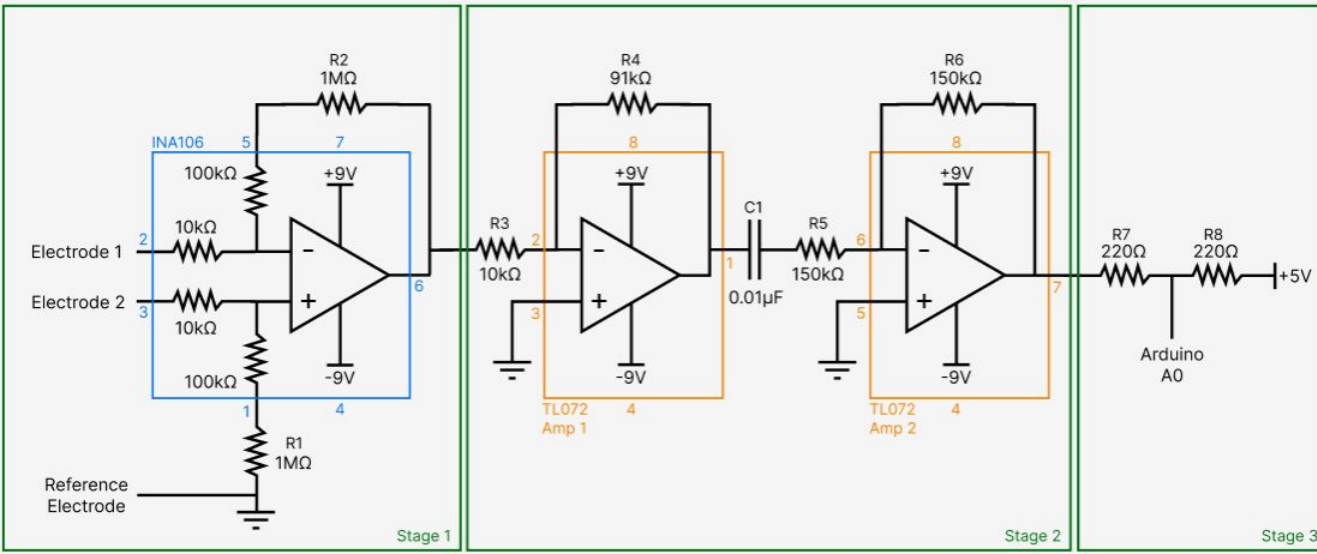
Image: TENS therapy [1]

Goals:

- Investigate effects of TENS treatment on muscle fatigue and recovery
- Compare our Arduino EMG design with iWorx

Methods (Arduino EMG)

- Signal acquisition was done with an INA106 precision fixed-gain differential amplifier
- Amplification was done with a TL072 low-noise FET input operational amplifier



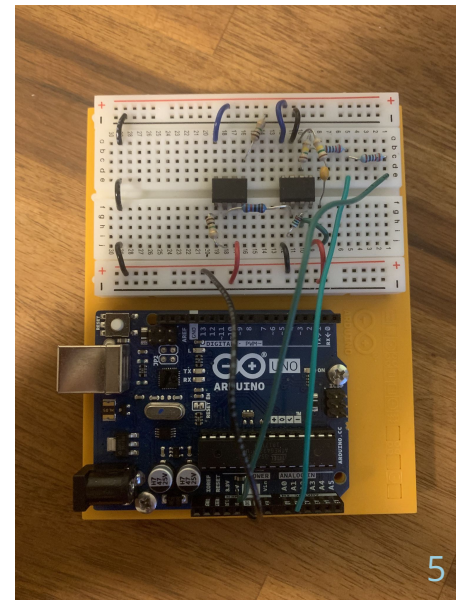
Experimental Protocol



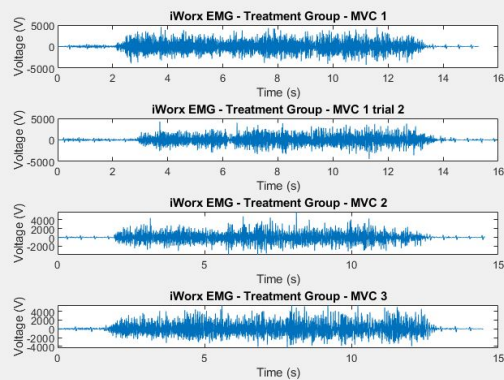
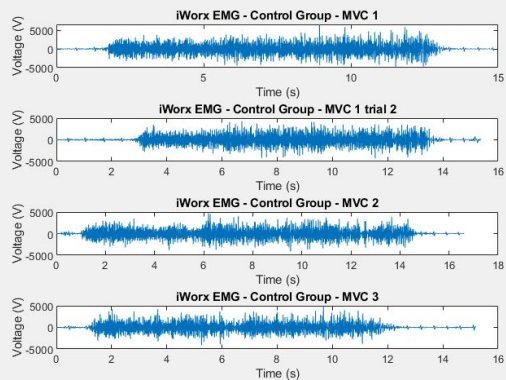
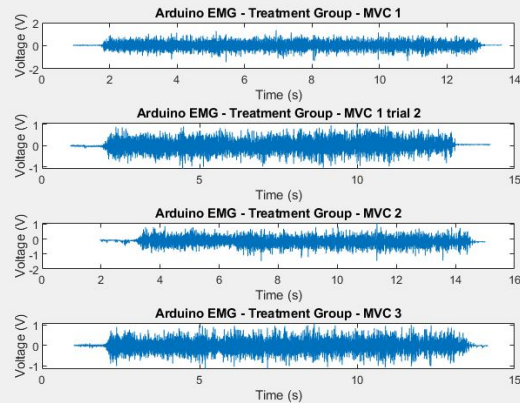
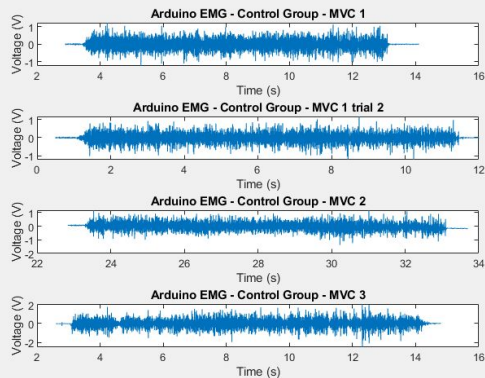
- 1) Two trials of isometric exercise Chest Squeezes (MVC) for 10 seconds
- 2) Two sets of push ups, 30/20 reps
- 3) Isometric Chest Squeeze (Fatigue)
- 4) Two Minute Rest Period (Control/TENS)
- 5) Final Isometric Chest Squeeze

Results (EMG)

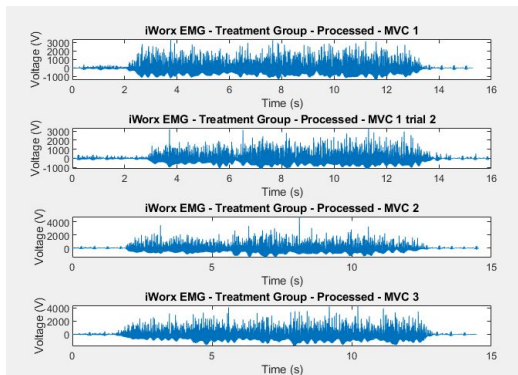
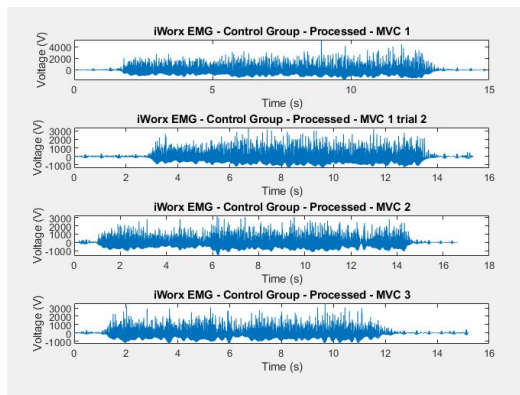
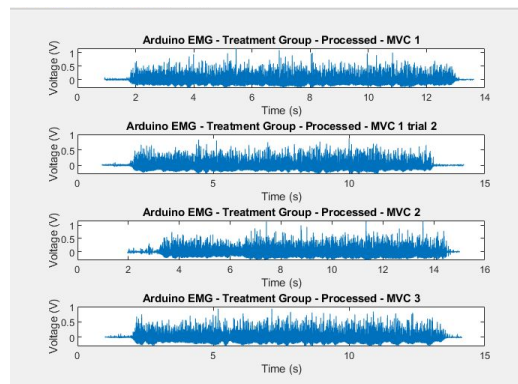
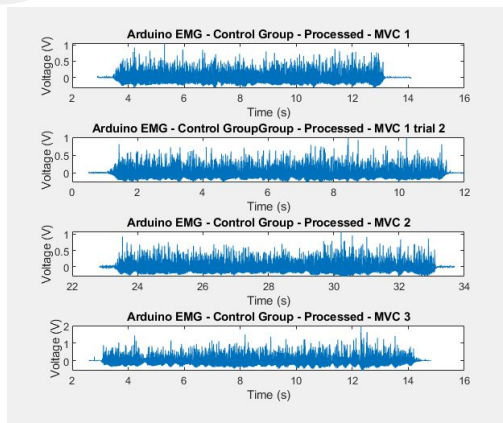
Specification	Arduino EMG	iWorx EMG
Common Mode Rejection Ratio	100dB [3]	120dB [4]
Gain	1001	25,000
Input Impedance	10k Ω [3]	10G Ω [b]
Distance to Signal Source	200cm	122cm [5]
Calibration, Adjustable Gains	No	Yes
Reliability	Low	High



Results



Results



Results

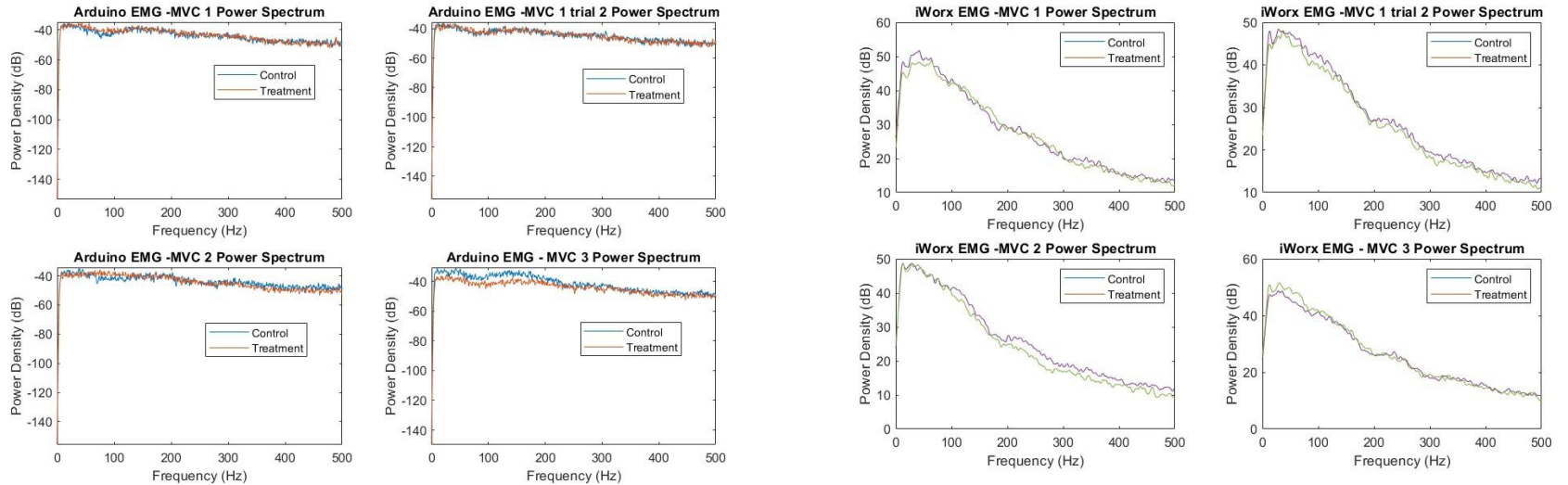


Figure 1: Power Spectrum Plots comparing treatment vs control for iWorx and Arduino systems.

Results

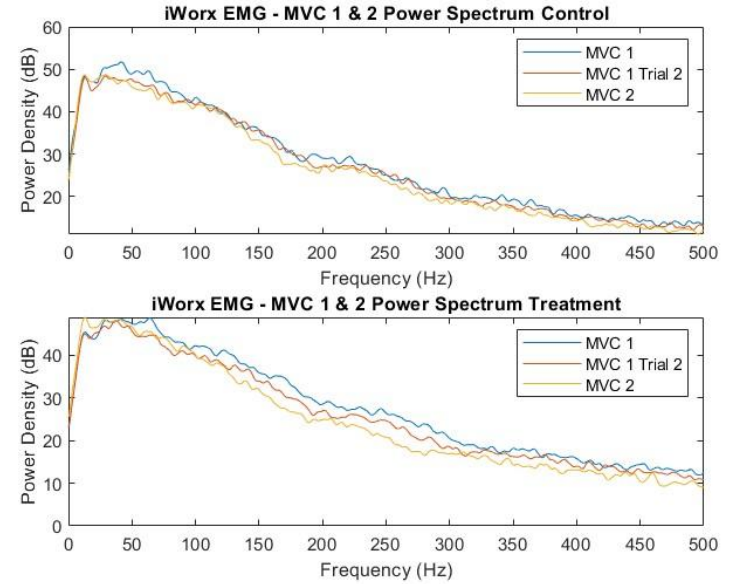
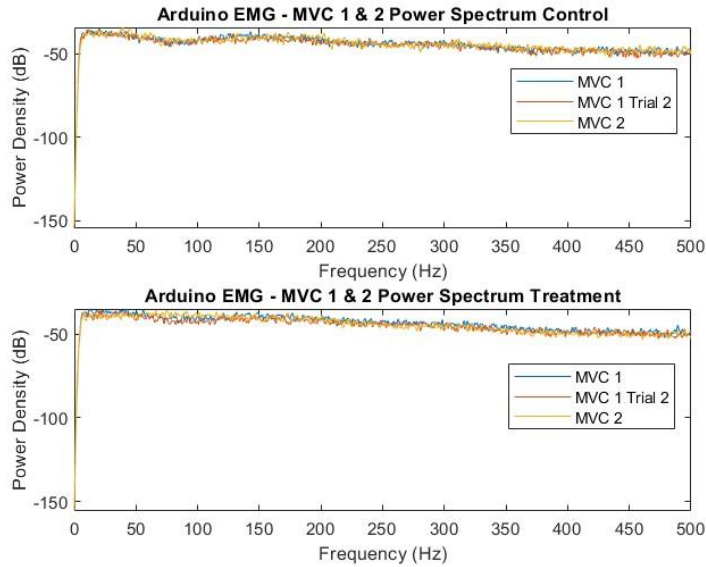


Figure 2: Power Spectrum Plots comparing MVC 1 & 2 for iWorx and Arduino systems.

Mann-Whitney U-test

Arduino sample		Power Spectral Density 1	Power Spectral Density 2	Median Power Frequency Diff	P Value ($\alpha = 0.05$)	Significance (H)
Control	Fatigue	MVC1	MVC2	-0.008757797	0.526887372	0
	Initial vs Final	MVC1	MVC3	-0.077566476	9.91E-73	1
	Recovery	MVC2	MVC3	-0.068808679	1.23E-68	1
Treatment	Fatigue	MVC1	MVC2	-0.00119508	4.75E-07	1
	Initial vs Final	MVC1	MVC3	0.003625088	2.11E-08	1
	Recovery	MVC2	MVC3	0.004820168	0.798089732	0

Mann-Whitney U-test

iWorx sample		Power Spectral Density 1	Power Spectral Density 2	Median Power Frequency Diff	P Value ($\alpha = 0.05$)	Significance (H)
Control	Fatigue	MVC1	MVC2	0.03053	1.06E-07	1
	Initial vs Final	MVC1	MVC3	0.11231	2.13E-09	1
	Recovery	MVC2	MVC3	0.081781	0.46031	0
Treatment	Fatigue	MVC1	MVC2	-1.44119	2.50E-12	1
	Initial vs Final	MVC1	MVC3	-1.07375	0.168517	0
	Recovery	MVC2	MVC3	0.367444	2.29E-08	1

Discussion (Arduino EMG)

Sample Rate:

- iWorx EMG - 5000Hz
- Arduino EMG - Variable (115200 baud rate)

Time (ms)	Sample Rate (Hz)
0-9 (0-0.009 seconds)	1422
10-99 (0.01-0.099 seconds)	1280
100-999 (0.1-0.999 seconds)	1163
1000-9999 (1-9.999 seconds)	1066
10000-99999 (10-99.999 seconds)	984

Improving Reliability:

- PCB with soldered connections
- Electrode button leads

Discussion

Treatment vs Control

- Power Spectrum: Not a significant difference seen in muscle activation with use of TENS
- Higher power at lower frequency reflects activation of large motor units
- More recovery shown through iWorx

MVC 1 vs MVC 2

- Power Spectrum: Slight decrease in MVC 2 suggesting fatigue
- With Arduino fatigue only detected in treatment

Conclusion

- There was no significant difference in muscle activation before and after receiving TENS treatment.

Limitations:

- We did control and treatment on the same day
- Testing only on a healthy individual

Future perspectives:

- Comparing muscle activation using microcurrent therapy vs TENS
- Testing on individuals with chronic pain or individuals who have less muscle activation
- Explore gender differences in muscle activation

Thanks! References & Questions

- [1] "Facts about TENS Therapy," *www.painscale.com*. <https://www.painscale.com/article/facts-about-tens-therapy> (accessed Apr. 04, 2023).
- [2] "Experiment: Exploring Rates of Fatigue," *backyardbrains.com*. <https://backyardbrains.com/experiments/rateoffatigue> (accessed Apr. 04, 2023).
- [3] "INA106 Precision Fixed-Gain Differential Amplifier," INA106 data sheet, product information and support | TI.com. [Online]. Available: https://www.ti.com/product/INA106?utm_source=google&utm_medium=cpc&utm_campaign=asc-null-null-GPN_EN-cpc-pf-google-wwe&utm_content=INA106&ds_k=INA106&DCM=yes&gclid=Cj0KCQjw2v-gBhC1ARIsAOQdKY2uGtcPeeP63Rt6AAL8nfrsP1OOszEwVYj-XCG7Lv3P_DfCm103MwaArCeEALw_wcB&gclsrc=aw.ds. [Accessed: 02-Apr-2023].
- [4] S. Day, "Important factors in surface EMG measurement," Cornell ECE. [Online]. Available: https://people.ece.cornell.edu/land/courses/ece5030/labs/f2009/EMG_measurement_and_recording.pdf. [Accessed: 02-Apr-2023].
- [5] "C-iso-FP," iWorx Systems Inc. [Online]. Available: <https://iworx.com/products/cables/recording-cables/c-iso-fp/>. [Accessed: 02-Apr-2023].