Evaluation of an Independent Neuromuscular Blockade Monitoring Device

E. Golomb[1], K. Ripley[1], D. Smith[1], J. Trinh[1], G. Atlas[1,2]

[1]Stevens Institute of Technology, Hoboken, NJ

[2]University of Medicine and Dentistry of New Jersey, Newark, NJ

Abstract

AcceleroMetrix has developed an independent muscle response sensor to objectively measure the level of neuromuscular blockade (NMB) in patients under general anesthesia without interfacing with a nerve stimulator.

Introduction

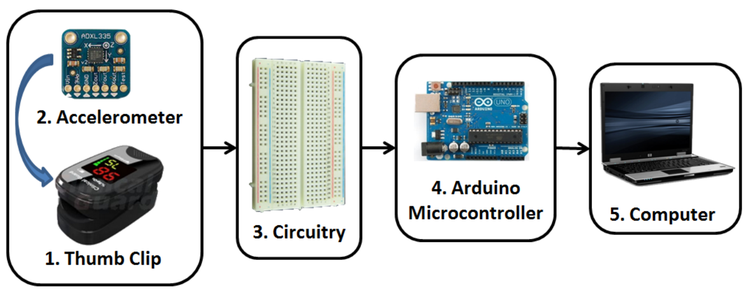
Neuromuscular blocking agents temporarily paralyze muscles to allow for easy tracheal intubation.

Gold standard NMB monitoring

- Train-of-four (TOF) monitoring measures the contraction of the adductor pollicis by electrically stimulating the ulnar nerve
- Determines appropriate time to prepare patient for extubation

Prototype Design

Prototype – TOF Clip



Purpose

- Measure acceleration of adductor pollicis contraction (thumb twitch) in 3 axes
- Accurately calculates TOF ratio
- Ensure TOF software works in conditions encountered during surgery

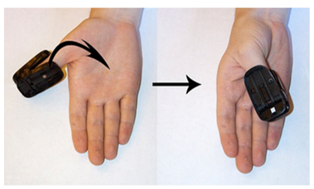
Software

- Identifies acceleration peaks from twitches
- Confirms if TOF test was performed correctly
- Equation: Acceleration of 4th to 1st twi

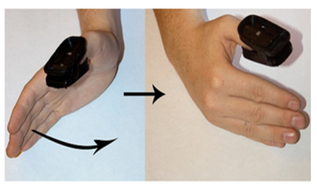
$$TOF\ ratio = \frac{a_4}{a_1}$$

Prototype Testing

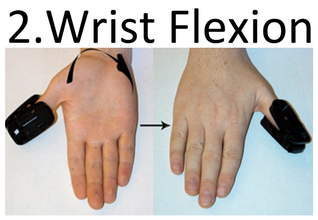
Types of Hand Motions



1.Thumb Twitch



2.Wrist Flexion



3.Hand Flip

Test Procedure*

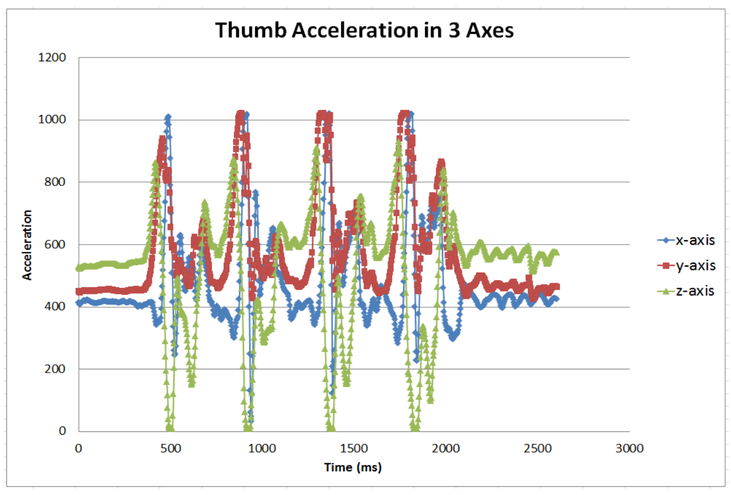
- 5 subjects
- 6 trials of each hand motion
- 2 Hz frequency (metronome)

*Performed without NMBAs or nerve stimulation

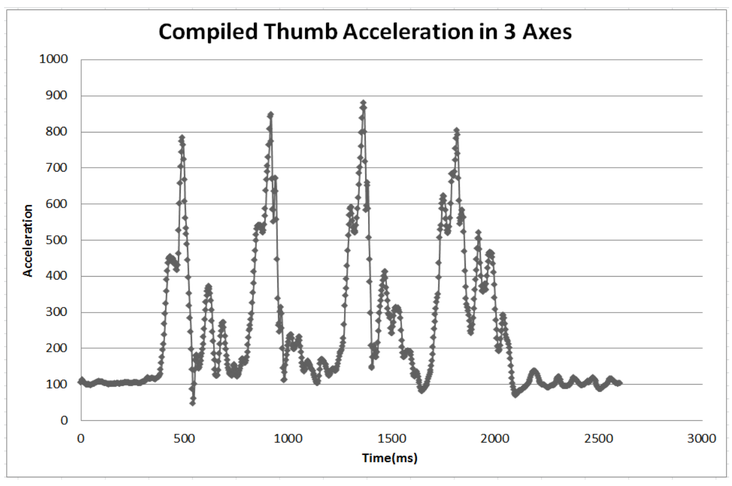
Data Analysis

- Signals of twitch vs. other hand motions
- Equivalence test: Software TOF vs. Manual TOF calculation
- Pass/fail criteria ± 0.05 of manually calculated TOF ratio

Results and Analysis



Each of the 3 axes has a different baseline based on the device's orientation



The root mean square composite of the 3 axes creates a consistent baseline regardless of clip orientation

Discussion

- Root mean square of 3 axes used to eliminate the effect of gravity
- Identified peaks belonging to twitches
- Frequency of thumb twitches were consistent in a TOF test
- Challenges arise when identifying correct peak in compiled data

Potential Benefits

Relationship: TOF to level of NMB

0.0 ← TOF Ratio → 1.0

High ← Level of NMB → Low

- Faster objective monitoring
- Determine critical level to intubate and extubate patient
- Prevent residual paralysis
- Reduce risks of NMBAs and reversal drug over dosage and related complications
- Compatible with independent stimulator

Recommendations

- Compare TOF Clip to existing TOF monitors interfaced with stimulator
- Evaluate in clinical trials on subjects under NMBA with nerve stimulation

Acknowledgments

Academic Advisor - Vikki Hazelwood, PhD

Teaching Assistant – Marissa Gray

References

[1] Plaud, B., Debaene, B., Donati, F. and Marty, J. (2010). Residual Paralysis after Emergence from Anesthesia. 1013-1022.

[2] D. Padmaja, S. M. (2002). Monitoring of neuromuscular junction. Indian Journal of Anaesthesia, 46(4), 279.