Resurrecting a 'Shocking' Dinosaur: Updating the Original Mechanomyography Gold Standard for 2020

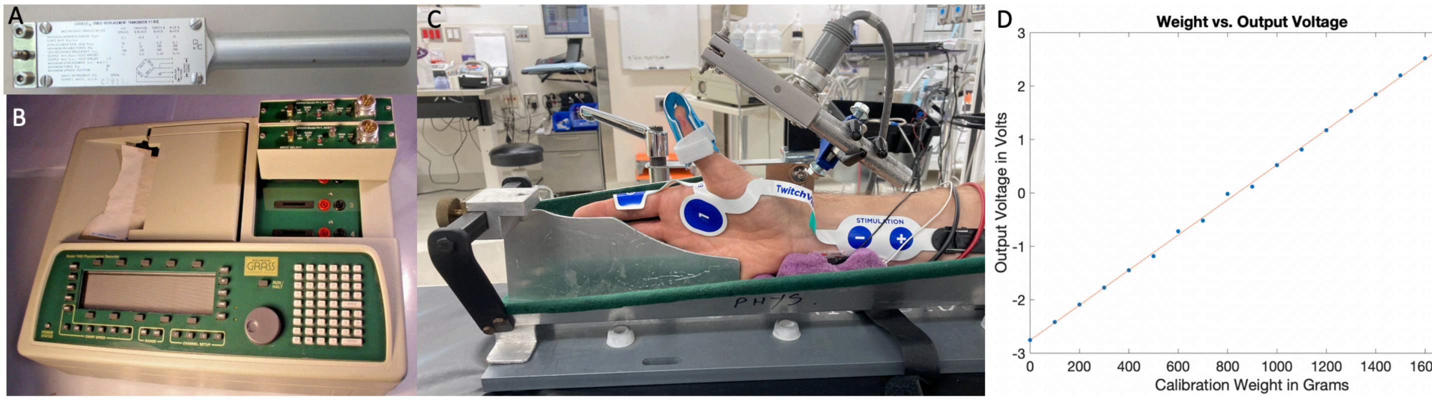
Presenting Author: Kelly Michaelsen, MD, PhD, University of Washington

Co-Authors: Srdjan Jelacic, T. Andrew Bowdle, MD, PhD, University of Washington

The gold standard assessment tool for measuring neuromuscular blockade (NMB) has traditionally been mechanomyography[1], despite the lack of commercially available testing systems. Recent advances in pharmacologic reversal as well as new commercialized electromyographic measurement tools have been hampered by a lack of access to this gold standard. Previously, at this conference, we demonstrated a novel mechanomyography device for assessment of quantitative train of four (TOF) ratio[2,3]. However, this device has never been externally validated through comparison with one of the original mechanomyography systems due to a lack of access[4]. Having recently obtained an original mechanomyography system modifications to the hardware and software have been made to allow the device to work with modern computers for comparison testing our new compact, inexpensive mechanomyography device.

Original studies used a Grass Instruments FT 10 force (Grass Instruments, Quincy, MA) transducer which we obtained in addition to a Grass Model 7400 physiological recorder (Astro-Med, Inc, Warwick, RI) as shown in the figure (A, B). The recorder has a small electronic display. Data results could be written in real time on a roll of graph paper (broken on our instrument) or saved to a 3.5" hard disk, neither of which are in use today. An analog output channel was available, which was functional after wire splicing, shielding and digitization via an analog to digital converter, NI DAQ USB 6009 (National Instruments, Austin, TX). A LABView (National Instruments, Austin, TX) program was written to control the data collection process and calculate the train of four measurements in real time.
After updating the data collection process, a complex arm holder was needed to suspend the force transducer above the hand of the patient as shown in the figure (C). Design considerations for this phase included minimizing force dispersions during high loads and keeping a precise parallel relative to the thumb to maximize the output signal. Using an old research arm holder device as a starting point, a mechanism for suspending the force transducer was built into it. The design allowed for multiple degrees of adjustment through set screws and a beaker clamp to adapt precisely for a given patient. The thumb is held in place by a disposable commercial finger brace suspended by Kevlar thread (Superior Threads, St. George, UT).

The system was calibrated using a series of weights up to 2kg (Ohaus, Florem Park, NJ) in order to calculate the system accuracy, precision, sensitivity and resolution, shown in figure (D). Data analysis was performed using MATLAB (Mathworks, Natick, MA). Measurement ranges were -3 to 3V for the original MMG and 0 to 5V for the new MMG. Both were highly linear, with original and new calibration R squared values of 0.999 and 1.000 respectively. Measurements were remarkably stable with mean standard deviation of 1.5 and 0.5 mV respectively for 1000 sequential samples at eighteen weights. Resolution of 0.36 and 0.31 mV and measurement precision to 56mV and 16mV respectively. This original system was less accurate than the new prototype mechanomyography system likely due to degradation of mechanical parts with time and the advent of more stable electronics over the past fifty years, other drawbacks include significantly longer set up time and larger size. The IRB approved patient trial of original mechanomyography compared with our new mechanomyography has been delayed by the pandemic but results will be presented at the conference if available.



Force transducer (A) and physiological recorder (B), hand setup (C) and device calibration (D)

1. Ali HH, Savarese JJ. Monitoring of Neuromuscular Function. *Anesthesiology*. 1976;45(2):216-249. doi:10.1097/00000542-197608000-00009
2. Bowdle A, Bussey L, Michaelsen K, et al. A comparison of a prototype electromyograph vs. a mechanomyograph and an acceleromyograph for assessment of neuromuscular blockade. *Anaesthesia*. 2020;75(2):187-195. doi:https://doi.org/10.1111/anae.14872
3. Bowdle A, Bussey L, Michaelsen K, et al. Counting train-of-four twitch response: comparison of palpation to mechanomyography, acceleromyography, and electromyography†. *Br J Anaesth*. 2020;124(6):712-717. doi:10.1016/j.bja.2020.02.022
4. Biro P, Paul G, Dahan A, Brull SJ. In Response. *Anesth Analg*. 2019;129(2):e62. doi:10.1213/ANE.0000000000004238