Developing Diagnostic Criteria for Muscle Jerks:

Poly-EMG in the Investigation of Movement Disorders

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Aim.

To refine diagnostic criteria for myoclonus by helping to **define normal limits** for EMG Burst duration in a range of muscles in healthy subjects, building on currently unpublished work[1].

Introduction

Myoclonus is a movement disorder characterised by involuntary bursts of muscular contraction, with many causes. Though rare, it can be a frequent issue for neurology patients and can be very disabling[2]. Identifying the aetiology is crucial for appropriate management, and measuring the electrical activity of muscles, **electromyography (EMG),** is an important first part of investigation.

Debate is ongoing surrounding the nature of some disorders. The presence of identifiable neuronal pathology classifies a disorder as either **organic** or **functional,** with functional displaying no abnormality. Diagnosis can be difficult, and existing criteria have been demonstrably lacking for some patient groups[3,4].

EMG Burst Duration helps differentiate disease processes, with diagnostic values used to distinguish organic disease; durations in functional disorders are less likely to fall outside the range of normal physiology. However, insufficient data exists to establish normal parameters.

Method.

20 participants recruited aged 20-59, no history of neurological diagnoses

Bipolar recordings were taken from 16 muscles on the participant's dominant side: 3 facial, 5 shoulder and back, 6 arm and 2 foot.

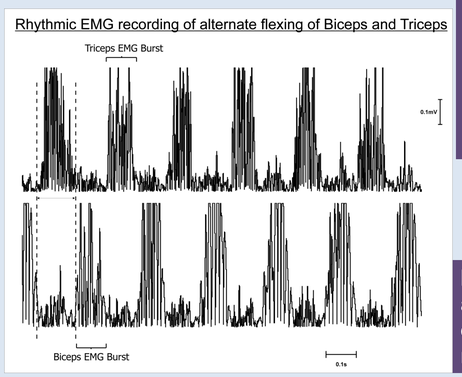
Participants were asked to make a single specific burst of voluntary movement for each muscle **(ballistic).** N ≥20 as briefly as possible

For each muscle, electrodes were placed as follows: cathode on the muscle bulk, anode on a suitable bony region, common ground on the ankle

Participants were also asked to alternately flex as quickly as possible **(rhythmic)** for the 2 combinations:

1) Biceps and Triceps
2) Flexor Carpi Ulnaris (FCU) and Extensor Digitorum Comminis (EDC)

D360 8-channel amplifier (Digitimer Ltd) allowed digitised data visualisation in **Spike2 software** (Cambridge Electronic Design Ltd).



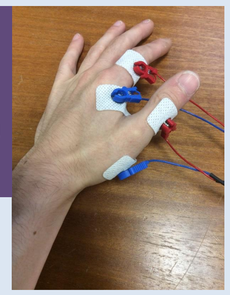


Image1: Picture showing EMG recording of hand muscles.

Figure 1: Rectified EMG appearance in Spike2. Double-ended arrow denotes measurement used for analysis

Results.

10 EMG bursts were selected at random for each muscle per participant. Cursors were placed at the start and end of a burst and measured, as per **Figure 1.**

Burst durations were compared statistically using t-tests (paired and unpaired) and corrected for multiple comparisons if required

1) Different muscle groups give different Burst Durations

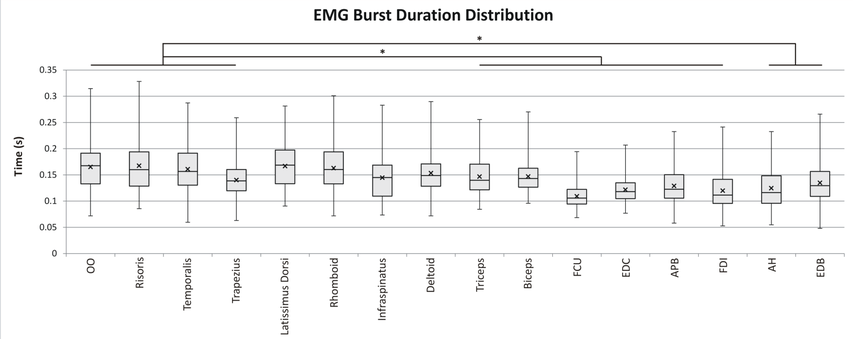
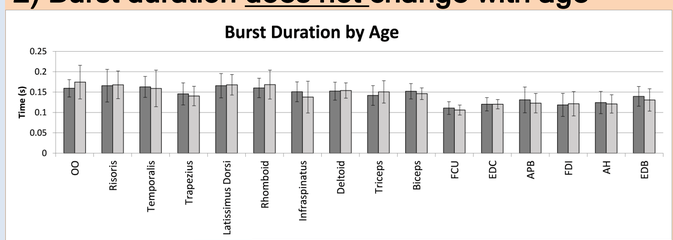


Figure 2: Range, Median, Mean and Inter-quartile range for ballistic EMG across all muscles. Significant difference (*) indicated between bracket-identified groups.

EMG distribution appeared similar, with mean averages above 100ms, yet differences are apparent. **Bulbar muscle averages were significantly longer** than Arm and Foot muscle averages ($p<0.001$). Generally, participants could produce quicker jerks the more peripheral the muscle used. No duration was less than **50ms,** the current benchmark for organic cortical disease[4].

2) Burst duration does not change with age

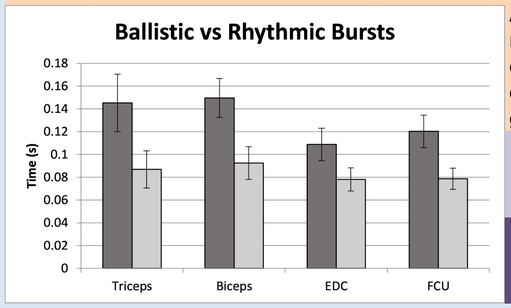


Key:
- Age 20-29
- Age 30-59

Figure 3: Mean and standard deviation of EMG Burst duration for both age groups

8 subjects were over and 12 were under 30 years old. On dividing subjects by age, **no significant difference** was found in any muscle. This concurs with previous work, adding validity to our findings[1].

3) Rhythmic movements significantly alters bursts duration



Alternate flexion of antagonistic muscles **significantly decreased** each burst duration. This may be due to the action of central pattern generators and reflex reciprocal inhibition, which have a similar role in the lower limb[5].

Key:
- Ballistic
- Rhythmic

Figure 4: Mean and standard deviation of upper limb burst durations

Conclusions

- Whilst similar, voluntary EMG Bursts differ significantly in duration according to muscle. Current diagnostic values refer to all muscles generically, so it is **appropriate and feasible** to produce more specific criteria[2].
- The current use of 50ms for cortical myoclonus is applicable. However, longer durations, especially in facial muscles, could still indicate organic disease.
- Criteria derived from this data should be applicable **across all age groups**
- Mimicking ballistic and rhythmic myoclonus give markedly different durations. Therefore, in assessing myoclonus, the **clinical picture** must be taken into account. Our data will be relevant only for ballistic movement.
- We have constructed a **table of reference values (Figure 5)** for clinical use. Confidence limits are provided as in a normal distribution, outside which there is a 1 in 20 probability that a result is due to chance. In more muscles this probability would multiply, hence the potential **clinical value.**
- **Future work** could involve collating this data with unpublished work to provide clinicians with a comprehensive range of values for most body muscles[1]. We hope this will **improve the accuracy and timeliness** of myoclonic diagnoses.
- We would need to test criteria clinically, using other tests involved in diagnosis to quantify usefulness of this approach[4].

Muscle	Mean	Standard Dev.	Lower 95% Limit	Upper 95% Limit
Orbicularis Oculi (OO)	165.37	30.83	103.71	227.04
Risoris	166.57	36.83	92.92	240.23
Temporalis	161.30	33.66	93.98	228.62
Trapezius	143.50	25.31	92.89	194.11
Latissimus Dorsi	166.60	27.37	111.85	221.34
Rhomboid	163.47	28.49	106.50	220.44
Infraspinatus	145.59	30.77	84.05	207.14
Deltoid	152.97	20.32	112.34	193.61
Triceps	145.28	25.25	94.77	195.79
Biceps	149.62	17.09	115.44	183.80
Flexor Carpi Ulnaris (FCU)	108.79	14.24	80.30	137.28
Extensor Digitorum Comminis (EDC)	120.26	14.27	91.72	148.81
Abductor Pollicis Brevis (APB)	127.64	28.37	70.91	184.38
First Dorsal Interosseus (FDI)	119.74	28.17	63.40	176.07
Adductor Hallucis (AH)	123.00	24.91	73.19	172.82
Extensor Digitorum Brevis (EDB)	136.00	25.18	85.65	186.35

Figure 5: Table displaying confidence limits calculated by doubling standard deviation and adding to and subtracting from mean. All values in milliseconds (ms)

Key:
- Bulbar Muscles
- Shoulder Muscles
- Arm Muscles
- Foot Muscles

References

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