Impairment in Leg Muscle Activity during a Balance Task Following a Stroke

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Do we know enough to reduce falls among stroke survivors?

- Stroke survivors have a high fall risk; impaired balance control is an important factor contributing to falls among patients [1,2].
- Current interventions are less effective as we do not understand *all* the factors contributing to poor balance control [2].
- *How stroke affects leg muscle activity during a balance task?*

Hypothesis:

Stroke patients will show reduced leg muscle activity on the affected side when compared to the non-affected side during a continuous balance task.

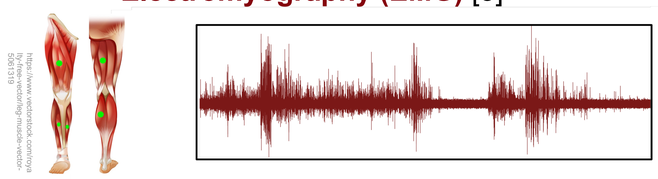
Approach: Multi-modal and Multi-system [3]

- Muscle activity: electromyography (EMG).
- Brain activity: electroencephalography (EEG).
- Balance performance: lab-based and clinical assessment.

How did we design and perform the study?

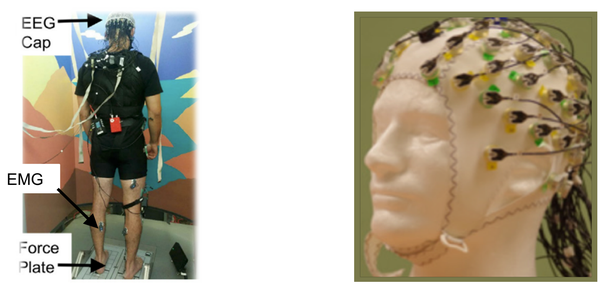
Stroke survivors (n = 4) and healthy control subjects (n = 1) provided informed written consent to participate in this study.

Electromyography (EMG) [3]

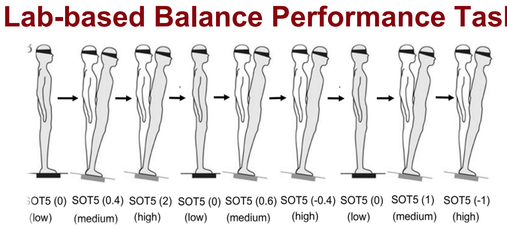


10 EMG sensors - Biceps Femoris, Rectus Femoris, Tibialis Anterior, Soleus, Gastrocnemius medialis

NeuroCom Balance Platform & Electroencephalography [3]



Lab-based Balance Performance Task [3]



The continuous balance task with varying difficulty levels: low, medium, and high (figure adopted from *Goel et al 2019* [3]).

Clinical tests

Berg Balance Scale (BBS) Timed Up and Go (TUG)

Montreal Cognitive Assessment (MoCA)

Do muscles on the affected side show reduced EMG activity than those on the non-affected side during a continuous balance task of varying difficulty?

Data Processing Approach

EMG Signal Processing

Import raw recorded EMG data for the 10 muscles of interest → Remove artifacts from raw EMG data using a bandpass filter → Synchronize EMG data with the balance platform data – segmenting data into 9 trials → Apply moving root mean square (RMS) for each trial

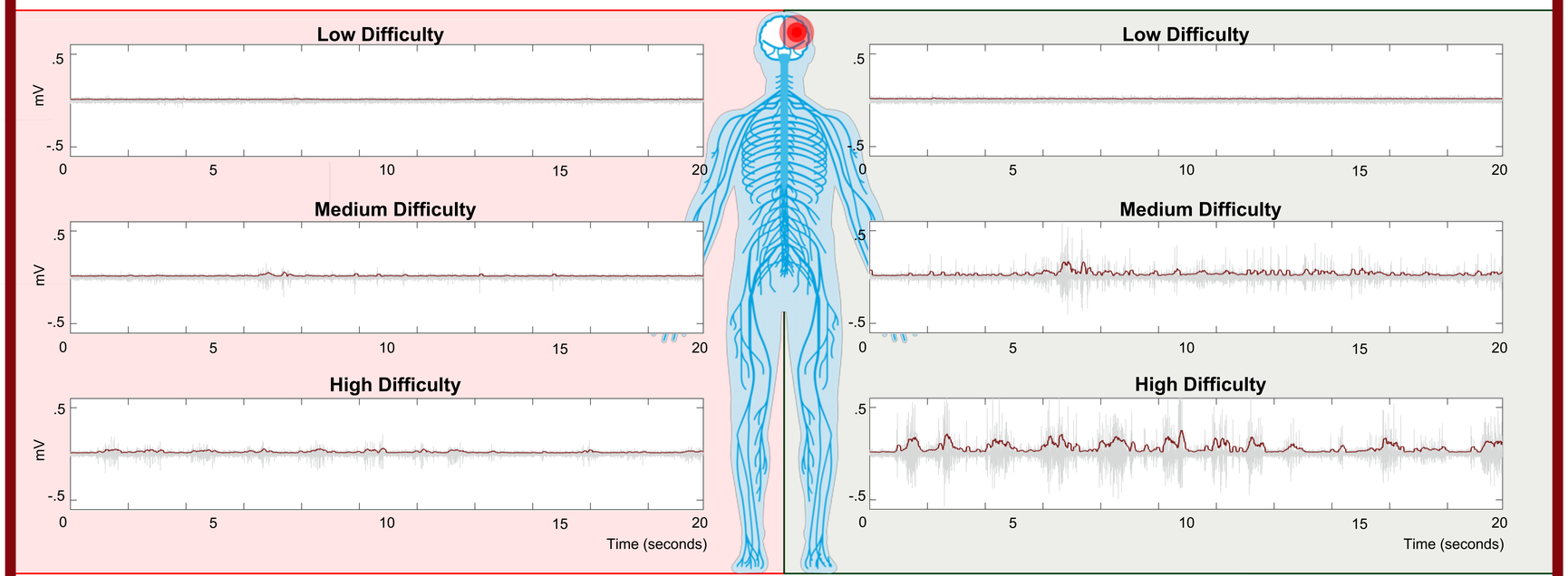
Creation of Figures

Create separate EMG plots for low, medium, and high difficulty trials → Organize plots for each muscle → Overlay RMS and raw EMG traces → Organize affected and non-affected EMG plots for visual comparison

Muscle Activity of Tibialis Anterior – representative stroke patient

Left Tibialis Anterior
Affected Side

Right Tibialis Anterior
Non-Affected Side



A right-sided stroke lesion led to reduced EMG activity in the left lower leg during the continuous balance task of medium and high difficulty conditions.

The difference in EMG activity is larger during high versus medium difficulty conditions.

= RMS of EMG
= Filtered Raw EMG
= Site of Lesion

Take-home message and implications for future studies

- Tibialis anterior EMG activity increased with increasing task difficulty.
- Post-stroke individuals show reduced muscle activity in the affected lower leg when compared to non-affected lower leg during balance task.
- Ongoing work involves data analysis and recruitment of more participants.

Long-term goal: to assess and design neuromodulation strategies to influence balance control in stroke survivors, using MRI- guided Transcranial Magnetic Stimulation (TMS).

ACKNOWLEDGEMENTS

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References

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