

Evaluating muscle changes in people with Charcot-Marie-Tooth disease using Electrical Impedance Myography

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I. Introduction

- Electrical Impedance Myography (EIM)** measures passive electrical properties in underlying tissue, using 4 surface electrodes.
- Charcot-Marie-Tooth (CMT)** leads to muscle atrophy from demyelination or axonal degradation.
- EIM Phase angle and phase ratios** reflect tissue health, with higher values indicating better cellular integrity.

Can EIM be a tool to measure degree of muscle atrophy in people with CMT disease?

II. Methods

- Study site:** Rikshospitalet, Oslo University Hospital, Norway.
- Electrodes placement:** using a stamp technique, organizing an electrode array, to secure fixed distances between electrodes at different (6) muscle sites (Fig. 1).
- At the same site; skeletal muscle (SM) thickness and subcutaneous adipose tissue (SAT) thickness were measured using an ultrasound device.

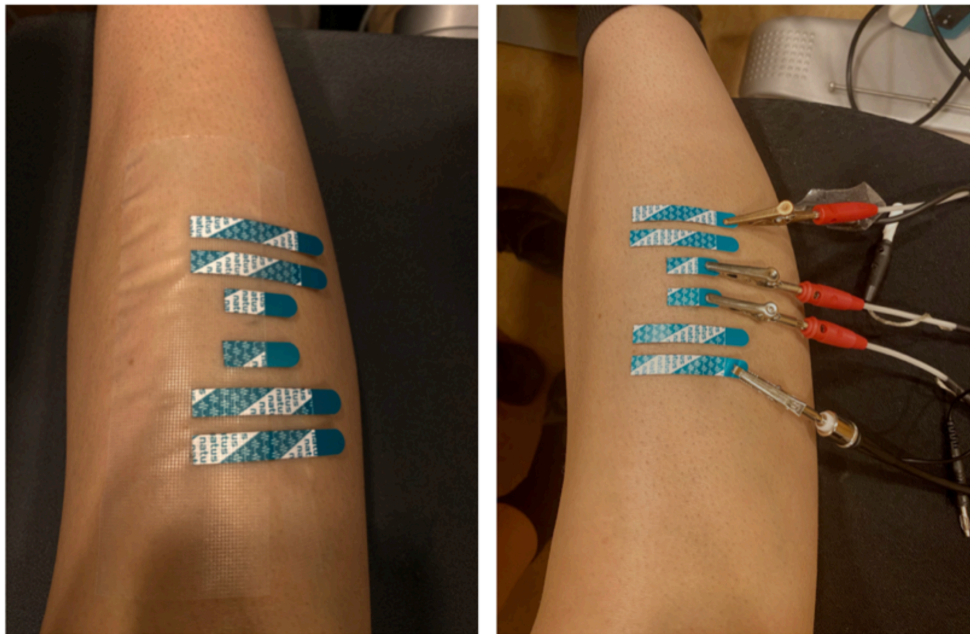


Figure 1: Electrode array placement was standardized using a stamp technique and adhesive fixation to improve measurement consistency across muscles and repeated assessments.

- Outcome variables:**
EIM parameters → Reactance (50 kHz), Resistance (50 kHz), Phase Angle (50 kHz), Phase Ratio (50/200 kHz, 100/300 kHz).
Ultrasound thickness → SM and SAT.
Clinical outcomes → CMT Neuropathy2 (disease severity)
- Statistics:**
 - Group differences [CMT/Control] → Mann-Whitney U-test.
 - Correlation EIM parameters and clinical outcomes → Spearman Correlation Coefficient.
 - Comparing parameters of different value ranges → Z-score normalization.
 - Removal of outliers → IQR removal (1.5).

V. References

- [1] A. Taruta et. al., *Exp. Neurol.*, 385, 115111, 2025.
[2] B. Sanchez and S. B. Rutkove *Neurotherapeutics.*, 14(1), 107-118, 2017
[3] S. B. Rutkove et. Al., *Sci. Rep.*, 13(1), 2023

III. Results

Demographics:

- CMT (N = 20):** 14F; 46.4 ± 13.3 y.
Median CMT Neuropathy2 score = 14 (min: 5, max: 23).
- Control (N=22):** 14F; 46.2 ± 13.0 y.

Ultrasound thickness:

- Tibialis Anterior (TA) shows greatest muscle thickness difference ($p < .001$) between groups (Fig. 2):
CMT: 20.7 (17.67-22.50) mm | **Control:** 25.9 (24.52-28.60) mm.

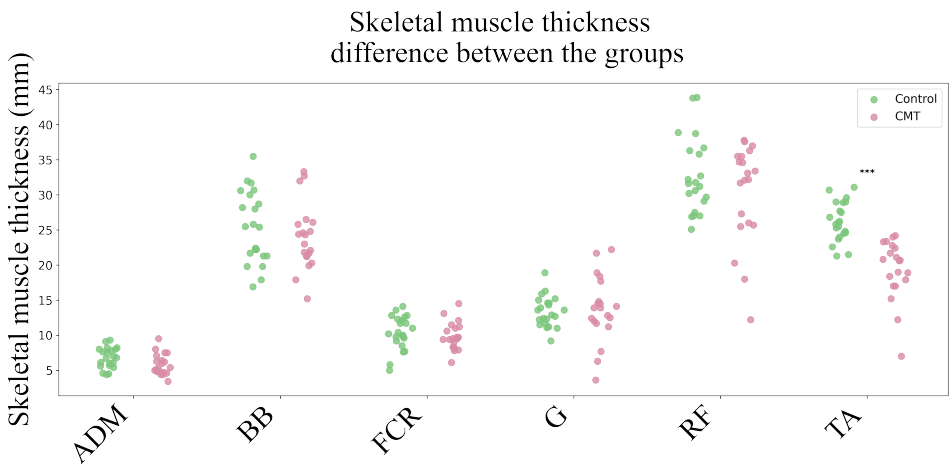


Figure 2: Ultrasound skeletal muscle thickness. Significant differences in muscle thickness between CMT/Control groups only for Tibialis Anterior and Abductor Digiti Minimi (ADM). (BB = Biceps Brachii, FCR = Flexor carpi radialis, G = Gastrocnemius medialis, RF = Rectus Femoris.)

EIM parameter group comparisons:

- For TA the parameter Phase Ratio 100/300 (PR 100/300) shows the greatest difference ($p = 0.008$) between the two groups (Fig. 3):
CMT: -0.62 (-0.90 - -0.09) | **Control:** 0.20 (-0.14 - 1.32).

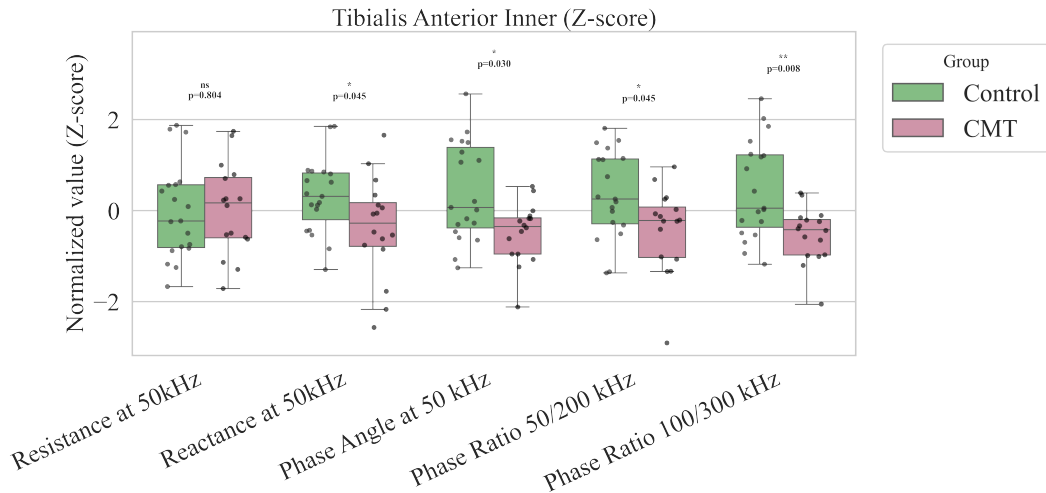


Figure 3: Results from EIM Parameters between the two groups. 4/5 parameters show significant difference in TA, the muscle which show the largest difference in muscle thickness. Z-score used to illustrate box-plots in similar scale.

Correlation with clinical values:

- PR100/300 and total CMT Neuropathy2 show a moderate negative correlation ($\rho = -0.462$, $p = 0.047$).

IV. Conclusion

- EIM are able to detect differences between the two groups in a muscle with measured thickness difference between the groups.
- The CMT group shows lower EIM values compared to control indicating lower cellular integrity and tissue health.
- The correlation between PR100/300 and total CMT Neuropathy2 score indicate that lower tissue health and cellular integrity leads to a higher Neuropathy score and more severe impairments in the CMT participant.
- Future work should apply PR100/300 Z-scores to investigate their potential as biomarkers of atrophic disease progression.