A Comparison of Different Methods to Calculate HDsEMG Centroid to Quantify Topographical Changes

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Summary

Multi-channel high density surface electromyography (HDsEMG) can be used to estimate muscle spatial activity. The change in the distribution of muscle activity during contractions can be evaluated by quantifying a shift in the centroid of the HDsEMG amplitude map, the point which defines the barycentre of muscle activation. The purpose of this study was to compare five centroid estimation methods during submaximal and maximal isometric plantarflexion to explore variations. Differences were noted in centroid directional shift suggesting the choice of method can impact interpretation of spatial muscle activity distribution.

Introduction

The centroid has been used to evaluate changes in spatial distribution of muscle activity and to locate different functional compartments in muscle [1]. Different methods have been proposed to estimate centroid [1-5] and comparison of these methods would be useful to determine the impact on signal interpretation. In this study five commonly used methods to estimate the centroid were compared.

Methods

Seventy-four men and women (mean age= 22.9± 2.0 years) completed isometric plantarflexion contractions at 25, 50, 75, and 100% MVC using an isokinetic dynamometer. HDsEMG electrode grids were placed over the medial and lateral gastrocnemius and soleus. Five methods were used to calculate the centroid across all contractions and compared (ANOVA, alpha level =0.05). Method 1 [1] used a 500 data point window and the centroid was calculated based on an 80th percentile threshold of the data. Method 2 [2] calculated the centroid by weighing coordinates by their Root Mean Square (RMS) values. Method 3 [3] was similar to Method 2 but with a different weighting approach. Method 4 [4] used RMS with weighted sums based on electrode grid coordinates while Method 5 [5] applied RMS values and specific weighting for rows and columns.

Results and Discussion

Significant differences in Cx and Cy were identified between Method 1 and all other methods ($p<0.05$). Specifically, it was found that Method 1 resulted in a right superior shift for the medial soleus' centroid (Figure 1). This finding was consistent for all contraction intensities; however, only 25, 50, and 75% MVC were found to be statistically significantly different ($p<0.05$). Methods 2 – 5 used weighted averages to represent centroid coordinates in the x and y directions. Method 1 used a new dimension reduction method to convert the spatial distribution of the motor unit action potential (MUAP) into a two-dimensional point compared to the centroid of the sEMG [1]. Method 1 separated individual muscle drive from the motor neuron pool and proved to be robust across individuals [5]. Methods 2 through 5 may not have enough resolution to identify specific shifts of activation distributions because they are limited to give the centre of the distribution and a different distribution shape may result in identical centroid. While Method 1 showed a significant right superior shift for the medial soleus during submaximal contractions, its clinical relevance should be further examined.

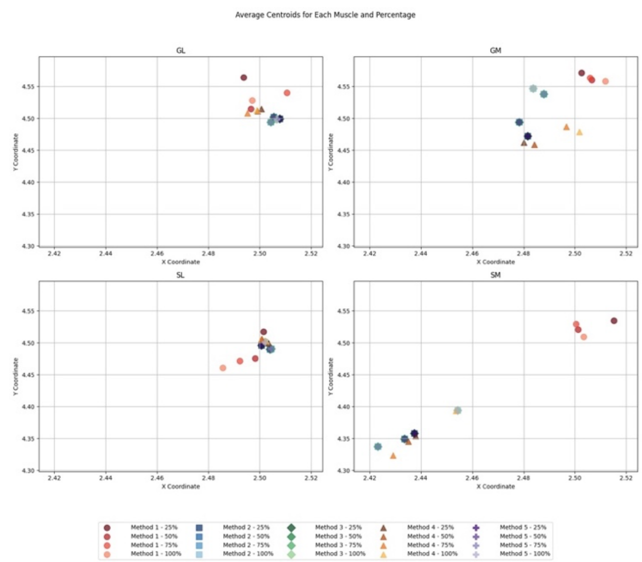

Figure 1: Average centroid (Methods 1 – 5) across all contractions.

Conclusions

Five common methods to estimate HDsEMG centroid during submaximal and maximal ankle plantarflexions were compared. Method 1 [1] was proposed as a more robust approach to centroid estimation. Future studies should consider these differences and consider the motor unit pool [1]. The architectural differences of the various muscles studied with each method may also impact interpretation and should be examined more closely.

Acknowledgments

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References

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