A Comparison of HDsEMG Features Between the Medial and Lateral Soleus During Isometric Plantarflexion

Timothy Green[1], Daniel Blustein[2], Victoria Chester[1], & Usha Kuruganti[1]
[1]Andrew and Marjorie McCain Human Performance Laboratory, University of New Brunswick, Fredericton, NB, Canada
[2]Faculty of Psychology, Acadia University, Wolfville, NS, Canada
Email: ukurugan@unb.ca

Summary

The triceps surae, comprised of the gastrocnemius and soleus, is the prime mover for plantarflexion. While significant differences in surface electromyography (sEMG) parameters have been identified between the gastrocnemii heads, differences between the solei subsections have been unexplored [1-3]. Currently, studies use the medial and lateral soleus interchangeably and assume that the solei subsections have similar sEMG parameters, which could affect electrode placement and lead to misinterpretation of recruitment strategies. The purpose of this study was to compare HDsEMG features between the solei subsections during prone submaximal and maximal isometric plantar flexion to identify neuromuscular differences. It was found that while the solei subsections were similar in activation amplitude, differences were noted in HDsEMG features at higher level contractions suggesting that the medial and lateral soleus should be considered separately. These findings have implications for electrode placement guidelines and our understanding of motor unit recruitment strategies of the soleus.

Introduction

The triceps surae muscle group plays a crucial role in activities of daily living. Past research has identified significant differences in spatial features of the gastrocnemii heads [3-4]; however, differences between the solei subsections are unknown. Generally, electrode placement for the soleus is on the lateral side but previous studies have used the medial and lateral subsections interchangeably [4]. Features of the HDsEMG may provide insight regarding differences between the solei subsections which could affect electrode placement and signal interpretation.

Methods

Seventy-four men and women (mean age= 22.87± 1.96 years) completed prone isometric plantarflexion contractions at 25, 50, 75, and 100% of maximum voluntary contraction (MVC) using an isokinetic dynamometer with 32-channel HDsEMG electrode grids placed over the medial and lateral soleus (OTBioelettronica, Turin, Italy). Root mean square (RMS) and median frequency (MDF) were calculated for each solei subsection [4,5]. Two-sample equivalence tests were used to compare these features. The equivalence threshold was estimated using the mean variance from the solei subsections from a subset of participant data (n=37) for a total of eight equivalence tests (Minitab 21, Vaughan, Canada).

Results and Discussion

At all contraction intensities it was found that the medial and lateral soleus produced equivalent RMS. However, for MDF, the solei subsections were not equivalent at 75 and 100% of MVC (Figure 1). Specifically, the lower equivalence bound was crossed for high and maximal intensities, suggesting that the lateral soleus had greater MDF. These findings suggest that at lower contraction intensities the solei subsections have equivalent RMS and frequency characteristics; however, as contraction intensity and motor unit recruitment increase, the lateral soleus median frequency increases to a value that surpasses the equivalence threshold.

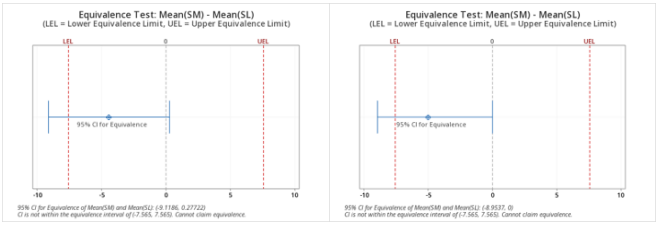

Figure 1: MDF equivalence test at high (left panel), and maximal (right panel) isometric plantarflexion contractions.

Conclusions

This study suggests that the medial and lateral soleus should not be treated as equivalent. Typically, the solei subsections have been used interchangeably in methods (e.g., electrode placement) and interpretation. The results suggests that they should be considered separately when recording muscle activity and, where possible, both subsections should be measured. The variations in MDF suggest that the lateral soleus may have a higher contribution of fast twitch muscle fibres, or that the medial soleus is at higher risk of fatigue at high intensity contractions. This work was limited to isometric plantarflexion. Future studies should examine dynamic activity as well as populations with altered motor unit recruitment (e.g. older adults) to gain greater insight.

Acknowledgments

This work was supported through NSERC Canada.

References

[1] Arampatzis et al., (2006). *J of Biomech*, **39:** 1891- 1902
[2] Riemann et al., (2011). *J of Str & Cond Res*, **25:** 634-639
[3] Cibulka et al., (2017). *Int J of Sport Phys Ther*, **12:** 233-241
[4] Vinti et al., (2018). *J of Elec & Kines*, **38:** 34-43
[5] Phinyomark et al., (2012). InTech eBook