

Leg muscle activation patterns in response to electromyography feedback of the calf muscles before and after an 8-week gait retraining intervention

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Summary

We examined the effects of an 8-week electromyography (EMG) biofeedback-based gait retraining intervention on lower limb muscle activation in older adults. Participants were trained to increase soleus and decrease medial gastrocnemius activation. Post-intervention, participants were able to selectively increase soleus peak activation while keeping the activation of other muscles statistically unchanged. EMG biofeedback can be used to specifically target soleus activation without affecting other muscles. Implications on tibiofemoral joint loads are to be examined in future.

Introduction

It has been demonstrated that EMG biofeedback targeting on the ratio of medial gastrocnemius and soleus muscle activations can be used to reduce tibiofemoral loads during walking in young adults [1], which is a target for many non-surgical knee osteoarthritis treatments [2]. This study investigated the effects of an 8-week EMG biofeedback-based gait retraining intervention on the activation of 11 lower limb muscles in older adults.

Methods

Thirty older adults (65–75 y.), free from musculoskeletal pain or neurological impairments, participated in an 8-week intervention that included gait retraining sessions once a week, along with pre and post intervention outcome assessments. As feedback, the root mean square (RMS) of the soleus and medial gastrocnemius EMG signals during the push-off phase of gait normalized to the corresponding value measured during walking without feedback (baseline) was displayed on a monitor while walking on an instrumented treadmill. The training aimed at adjusting the activation ratio of the soleus and medial gastrocnemius muscles, ideally by increasing soleus activation while simultaneously decreasing medial gastrocnemius activation. In the pre and post interventions sessions, EMG was measured from 11 lower limb muscles. One sample t-test was used to compare peak stance phase EMG values between baseline and biofeedback walking trials.

Results and Discussion

Before the 8-week gait retraining intervention, an increase in activation was observed in the soleus, medial gastrocnemius, and lateral gastrocnemius muscles when receiving feedback compared to baseline walking (Figure 1). Following the intervention, only the soleus and rectus femoris muscles showed a significant increase in activation, while the activation of other muscles remained statistically unchanged (Table 1).

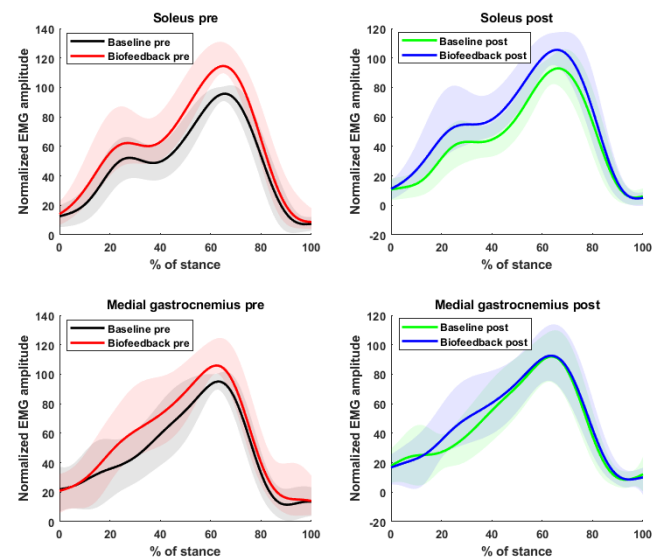


Figure 1: Mean soleus and medial gastrocnemius muscle activations in baseline and biofeedback walking trials pre and post intervention.

Conclusions

The results show that the intervention improved the participants' capability to independently control synergistic calf muscles. In addition, the results verify that it is possible to modify calf muscle activation with minimal impact on the activation of other lower limb muscles. Reduction of gastrocnemius activation proved to be difficult, which potentially limits the utility of the intervention for reducing tibiofemoral joint loads.

References

- [1] Uhlich et al. (2022). *Sci. Rep.*, **12**:1-13.
- [2] Andriacchi et al. (2004). *ABME*, **32**:447-457.

Table 1: Percentage changes from baseline walking pre and post intervention, with statistically significant differences marked by an asterisk (*).

	Soleus	Medial gastrocnemius	Lateral gastrocnemius	Tibialis anterior	Vastus lateralis	Rectus femoris	Vastus medialis	Biceps femoris	Semi-tendinosus	Gluteus maximus	Gluteus medius
Pre Δ%	19.69*	13.76*	14.76*	-4.86	-3.97	5.31	-1.53	-3.98	1.07	-2.34	-4.64
Post Δ%	12.74*	-3.59	3.74	-3.47	10.33	16.79*	12.10	0.63	-4.41	-5.00	-5.10